Aviation Week

Including Space Technology

Air Force Unit Backs Studies of Space Problems

Sperry Sergeant Missile

JET 880

Among airlines to first offer Convair Jet 880 service will be
TWA, DELTA,
Transcontinental, S.A. *(Argentina),*
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CONVAIR'S JET 880

Travel treasure for the new jet age

With superior speed, dramatically stylized interiors, two-abreast seating and the ultimate in engineering, the luxurious *Convair Jet 880* leads the way into the jet-travel era. To the passenger this affords even greater saving of travel time, less travel fatigue, a minimum of possible en route delays, and complete peace of mind and comfort. These dynamic passenger appeals assure untold *travel treasures in the new jet age!*

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A DIVISION OF GENERAL DYNAMICS CORPORATION

Vickers hydraulic motor and control valve "package" for hose reel drive.

- **WEIGHT SAVING...** Approximately 90% lighter than former electric drive.
- **SIMPLICITY...** Fewer parts, greater inherent reliability.
- **AUTOMATIC TENSION CONTROL...** Hydraulic sensing device eliminates unscheduled disconnects.
- **FASTER RESPONSE...** Low-inertia hydraulic motor can be started, stopped, reversed instantaneously (1½ revolutions between full speed in opposite directions).
- **EXPLOSION PROOF...** Without added weight.

Why Flight Refueling, Inc., now uses VICKERS® Hydraulics on Hose Reel Drives

To obtain optimum performance of in-flight refueling equipment, Vickers Incorporated has worked closely with Flight Refueling, Inc., in adapting the inherent advantages of hydraulics to this tactically important air-weapons concept. The significant results of their combined efforts are enumerated above.

The use of Vickers hydraulics has broadened the scope of in-flight refueling applications. The automatic sensing device and fast response of the hydraulic motor prevents disconnects. Commercially, the hydraulic system permits bigger payloads and extended flying range. For more information, contact the nearest office listed below. Write for SS-1010.

7892

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DIVISION OF SPERRY RAND CORPORATION

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Department 1462 • Detroit 32, Michigan

TORRANCE, CALIFORNIA • 3201 Lomita Boulevard
P.O. Box 2003 • Torrance, California

Aero Hydraulics Division District Sales and Service Offices **• Albertson, Long Island, N.Y., 882 Willis Ave.**
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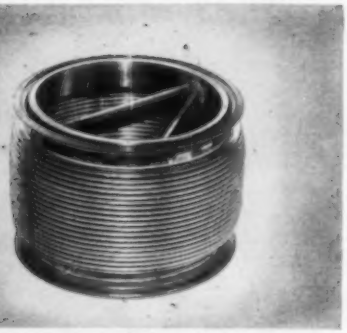
Additional Service Facilities at: **Miami Springs, Fla., 641 De Soto Drive**

TELEGRAMS: Vickers WUX Detroit, TELETYPE: "ROY" 1149 • CABLE: Vidat
OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

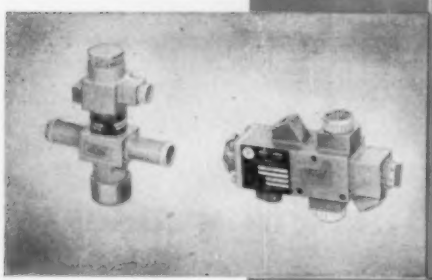
Engineers and Builders of Oil Hydraulic Equipment Since 1921

API*



Hot air flexible tension type duct joints; temperature to 850°F; flow rates 18,000 lbs. per hour; rotating and non-rotating types; angular displacements to 25° included cone; sizes to 5 inches diameter.

Hot air shut-off and pressure regulator; temperatures to 815°F; inlet pressure to 250 p.s.i.; outlet pressure range from 5-30 p.s.i.g. ± ½ p.s.i.



Valves for special fluids and gases; valves shown used at fluid temperature 350°F.

Pneumatic actuators with integral pressure snubbers, external buffer cylinder, integral filler-check valve, filters, etc., for operating pressure to 3000 p.s.i.

3000 p.s.i. Hydraulic Actuator with internal pressure actuated locks and electric limit switches.

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The items shown represent a small cross section of the numerous precision component parts designed, developed, qualified, manufactured by Randall Engineering Corporation to be used in the latest missiles and aircraft. The component's function and reliability in the complete system are given primary consideration in its development.

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AVIATION CALENDAR

Apr. 14-16—51st General Conference of the Federation Aeronautique Internationale, Ambassador Hotel, Los Angeles, Calif.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton-Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York City.

Apr. 21—Syracuse Transportation Conference and Salzberg Memorial Lecture, Syracuse University, Syracuse, N. Y.

Apr. 21-23—14th Annual Meeting Metal Powder Assn. and Powder Metallurgy Show featuring applications of powder metallurgy parts in nuclear, jet and rocket engine fields. Sheraton Hotel, Philadelphia, Pa.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Apr. 22-24—1958 Annual Convention, International Airline Navigators Council, Picadilly Hotel, New York, N. Y.

Apr. 24—Eastern Regional Meeting, Institute of Navigation, Friendship International Airport, Baltimore, Md.

Apr. 24-26—Joint Meeting, International Scientific Radio Union and Institute of Radio Engineers, Willard Hotel, Washington, D. C.

Apr. 28-30—Second Annual Astronautics Conference, sponsored by Air Force Office of Scientific Research and Institute of Aeronautical Sciences, Shirley Savoy Hotel, Denver, Colo.

May 4-7—Fourth National Flight Test Instrumentation Symposium, Park Sheraton Hotel, New York City.

May 5-7—1958 National Symposium, Professional Group on Microwave Theory and Techniques of the Institute of Radio

(Continued on page 6)

AVIATION WEEK Including Space Technology

April 7, 1958

Vol. 68, No. 14

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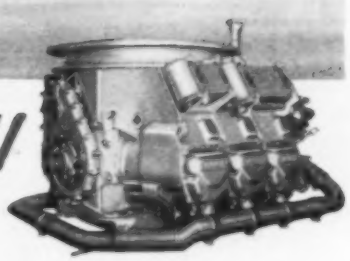
30,335 Feet UP!



...CESSNA YH-41 HELICOPTER

Sets New World Record, with Continental Power

When Capt. James E. Bowman of the U. S. Army Aviation Board flew the Cessna YH-41 to a new helicopter world altitude record of 30,335 feet, he added another to the long list of major performance records already held by Continental aircraft power. Capt. Bowman's mark, exceeding by some 3,400 feet the previous helicopter record, underscores again the wisdom of engineering the power to its job. The YH-41's Continental FSO526 engine is designed expressly for helicopter use . . . fan-cooled for efficient cooling in submerged installation . . . supercharged for maximum power. Its horizontal configuration permits the engine to be located forward, bringing the load directly below the rotors—an ideal situation in helicopter loading arrangements. Finally, the interchangeability of many parts with those of other models in the Continental aircraft engine line tends to simplify service, and reduce its costs.

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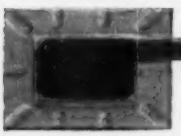
actual size

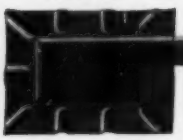


CEMENT-ON*, Type 1375

The temperature sensing element is encased by a die-formed wire screen which can be installed on any surface with TRANS-SONICS Type 64C cement.

TYPE	TEMPERATURE RANGE
1375A	−300 to +650F.
1375B	0 to 1000F.
1375C	+200 to 1250F.
1375D	+500 to 1550F.

actual size



WELD-ON*, Type 1376

The temperature sensing element is encased in a thin die-formed metal cover, and is installed by spot welding the cover to the underlying metallic surface.

TYPE	TEMPERATURE RANGE
1376A	−300 to +650F.
1376B	0 to 1000F.
1376C	+200 to 1250F.
1376D	+500 to 1550F.

- RANGES: From −400F to +1550F.
- OUTPUT: Up to 5 volts without amplification.
- RESISTANCE CHANGE: 100 ohms over calibrated range.
- ACCURACY OF CALIBRATION: ±1% of range interval
  ±2% for temperatures over 1000F.
- MAXIMUM CONTINUOUS CURRENT: 20 milliamperes rms.
- REPEATABILITY: ±0.2% of range interval.
- VIBRATION: 1-inch double amplitude, 0-22 cps;
  25g, 22-2000 cps.
- ACCELERATION & SHOCK: 100g on all three major axes.
- LEADS: Two 6" nickel wires with high temperature insulation.

Trans-Sonics Cement-On Type 1375 and Weld-On Type 1376 Surface Temperature Transducers are platinum resistance thermometers that can be installed on any surface, flat or curved, metallic or non-metallic, for accurate temperature measurement. The protective cover of the resistive element is cemented or welded directly to the thermal surface to form an isothermal system which gives a transducer reading that corresponds to the true skin temperature.

A 5 point resistance-temperature calibration certificate at 0, ¼, ½, ¾ and full scale temperature is supplied with each transducer. A strip of aluminum Thermotape* is also furnished with each unit to provide an alternate means of tape-on installation useful to 800F and under limited conditions to 1000F.

Types 1375 and 1376 are the newest members of the Trans-Sonics family of platinum resistance thermometers for measuring surface temperatures. All units are capable of delivering up to 5 volts without amplification. Write to Trans-Sonics, Inc., Dept. 7, Burlington, Mass. for Technical Bulletin on Surface Temperature Transducers.

*TRADEMARK

TRANS-SONICS

Precision Transducers

AVIATION CALENDAR

(*Continued from page 5*)

Engineers, Cubberley Auditorium, Stanford University, Stanford, Calif.

May 12-14—National Conference on Aeronautical Electronics, sponsored by Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 12-14—Institute of The Aeronautical Sciences' National Midwestern Meeting on Guided Missiles (Classified), Hotel Chase, St. Louis, Mo.

May 12-16—Airport Operators Council 11th Annual Meeting, El San Juan Intercontinental Hotel, San Juan, Puerto Rico.

May 14-16—Spring Meeting, Society for Experimental Stress Analysis, Hotel Manger, Cleveland, Ohio.

May 19-22—17th Annual National Conference, Society of Aeronautical Weight Engineers, Inc., Belmont Plaza Hotel, New York, N. Y.

May 19-23—Annual Aviation Seminar and Meeting, National Fire Protection Assn., Palmer House, Chicago, Ill.

May 25-31—1958 Aviation Writers Assn. Convention, the Shamrock Hilton, Houston, Tex.

June 2-4—National Telemetering Conference, Lord Baltimore Hotel, Baltimore.

June 2-4—Short Course and Conference on Automation and Computers, University of Texas, Austin, Tex.

June 4-5—West Coast Magnesium Symposium, correlated program by the Society of Aircraft Materials and Process Engineers and the Magnesium Assn., Institute of Aeronautical Sciences Bldg., Los Angeles, Calif.

June 9-12—Materials Handling Conference, sponsored by American Society of Mechanical Engineers, Public Auditorium, Cleveland, Ohio.

June 16-18—Second National Convention on Military Electronics, Sheraton Park Hotel, Washington, D. C.

June 23-July 3—Special Summer Program on Random Vibration, an introduction to the vibration problem in missiles and jet aircraft, Massachusetts Institute of Technology, Cambridge 39, Mass. For details write: Dr. Stephen H. Crandall, Associate Professor of Mechanical Engineering, M. I. T.

June 25-27—Air Transportation Conference, sponsored by American Institute of Electrical Engineers, Hotel Statler, Buffalo, N. Y. For information: S. H. Hanville, Jack & Heintz, Cleveland 1, Ohio.

July 14-15—Triennial Inspection, National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, Moffett Field, Calif.

Aug. 19-22—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Sept. 3-5—1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass.

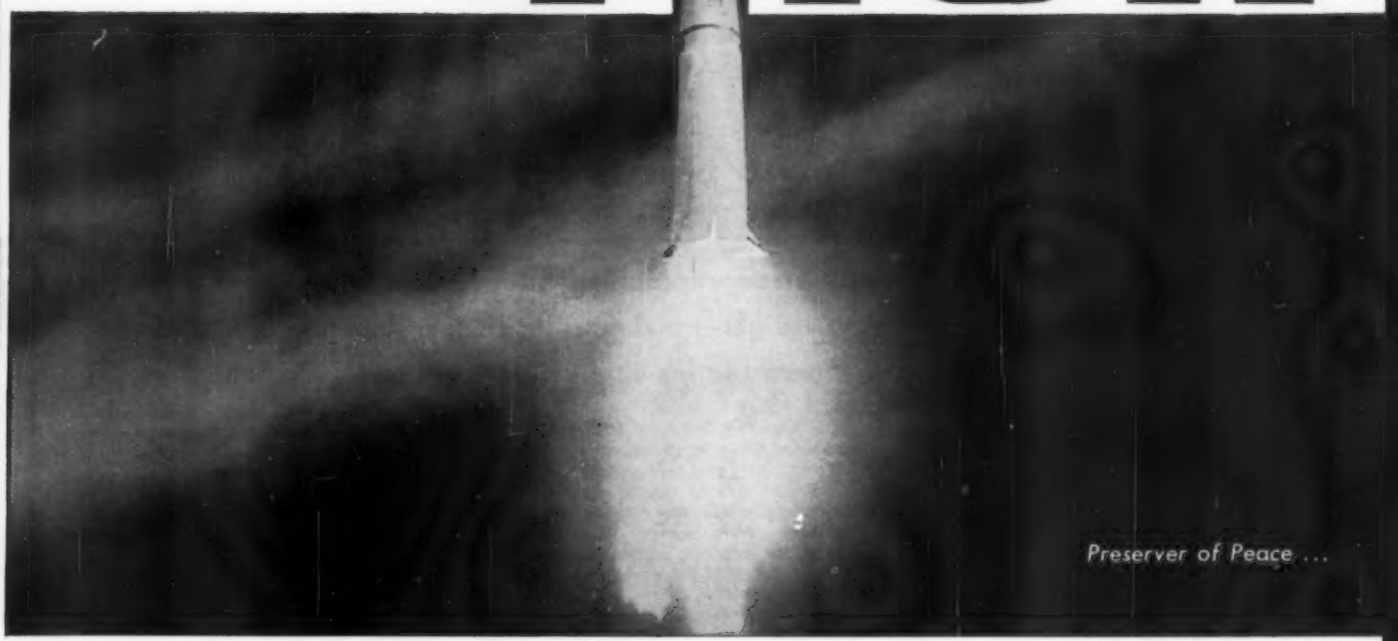
Sept. 6-14—International Aviation Show, Coliseum, New York, N. Y.

Sept. 8-13—First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

Oct. 27—14th Annual General Meeting of the International Air Transport Assn., New Delhi, India.

Thunder of a 1,500 mile thrust...

THOR



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The very heavens shake with the thunder of some 135,000 horses as Thor streaks across the sky at 10 times the speed of sound. Designed by Douglas Aircraft to deliver total destruction to targets as far away as 1,500 miles, Thor represents the Air Force's striking arm where ground objectives are concerned. For this surface-to-surface intermediate range ballistic missile, with its inertial guidance system, RCA has developed and is supplying electronic units to help Thor declare its mission: the prevention of war.

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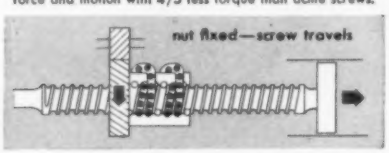
NUT TRAVELS: When rotary motion is applied to the screw, the b/b nut glides along the axis of the screw on rolling steel balls, converting rotary force and motion to linear force and motion with 4/5 less torque than acme screws.



SCREW TRAVELS: When rotary motion is applied to the b/b nut, the screw glides along its longitudinal axis on rolling steel balls, converting rotary force and motion to linear force and motion with unprecedented efficiency.

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It's another first from Saginaw—and the possibilities it opens up for improved electrical and electronic controls are limited only by your imagination! Radar tuners, missile and rocket guidance and telemetering systems, automatic switchgear, electronic machinery controls are just a few of the applications where this new miniature Saginaw b/b Screw will solve critical positioning/control problems. *It's so compact and light,* you can save substantially on space and weight. *It's so efficient,* (over 90%) you can use much smaller motors and gear boxes. *It's so precise,* you can position components within .0005 inch per inch of travel. *It's so dependable,* you can rely on remarkably long service life even in adverse environments.

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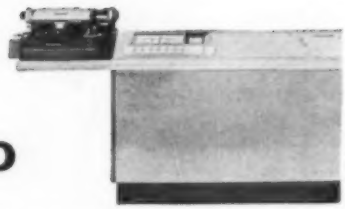

Compare it, feature by feature, with the other computers in its class

Feature	Computer A	Computer B	Computer C	Computer D	LGP-30	
Memory Size	220 words for data only	2160 words	1000 or 2000 words	84 words for data only	4096 words for data & program (either or both)	LARGEST CAPACITY IN ITS CLASS
Max. Speed Add Multiply	 20/sec. 4/sec.	 Comparable to LGP-30	 Comparable to LGP-30	 3/sec. 1/sec.	 Over 440/sec. Over 50/sec.	SPEED EQUAL TO MANY ROOM-SIZED COMPUTERS
Size	17 sq. ft.	6.5 sq. ft. plus table for typewriter.	45 sq. ft.	9.2 sq. ft. plus table for typewriter & control unit.	11 sq. ft.	COMPACT, DESK-SIZED, COMPLETELY MOBILE
Input-Output	Keyboard only — tape at extra cost.	Independent tape preparation at extra cost.	Extra cost peripheral equipment required.	Tape and typewriter for numerical input-output only. Independent tape preparation at extra cost.	Tape typewriter for alpha-numeric input-output standard equipment.	DELIVERED COMPLETE. NO ADDITIONAL EQUIPMENT NEEDED TO PREPARE DATA, PROGRAM OR REPORTS
No. of tubes	165	450	2,000	248	113	FEWER COMPONENTS MEAN LESS MAINTENANCE, FEWER CHECKOUTS
Voltage	220 V	110 V	220 V	110 V	110V	PLUGS INTO ANY REGULAR WALL OUTLET
Power	2.5 KW	3.0 KW	17.7 KW	1.65 KW	1.5 KW	NO SPECIAL WIRING OR AIR-CONDITIONING REQUIRED
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Cost Sale Rental	 $38,000 $1000/mo.	 $49,500 $1485/mo.	 $205,900 $3750/mo. up	 $55,000 $1150/mo.	 $49,500 $1100/mo.	LOWEST COST EVER FOR A COMPLETE GENERAL PURPOSE COMPUTER

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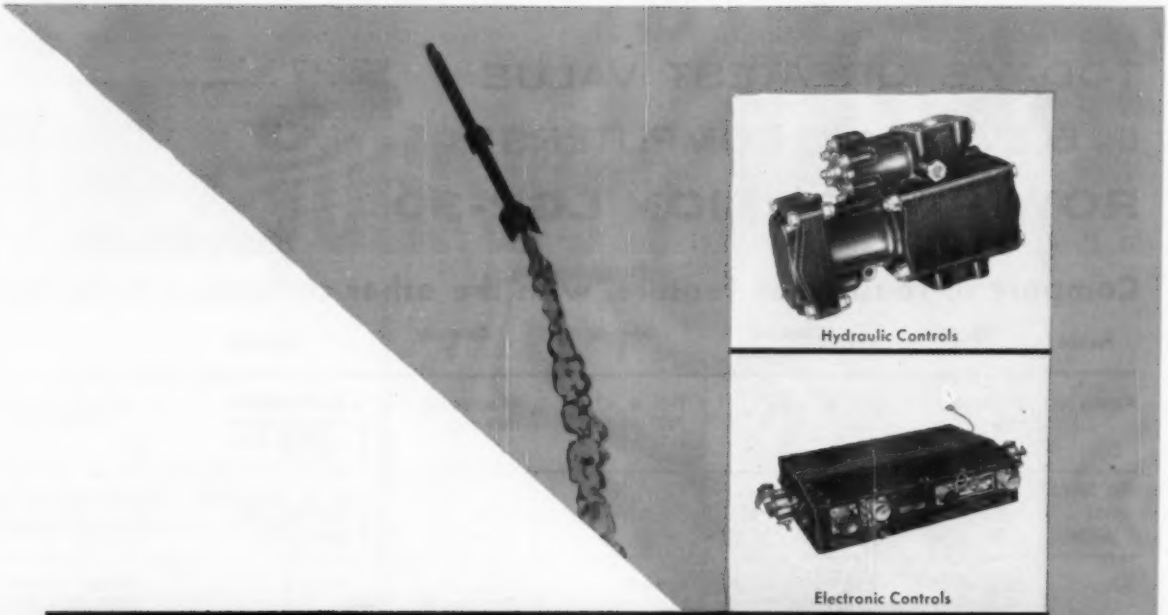

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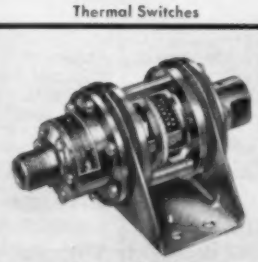
Thermal Switches



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OUR AIRCRAFT PRODUCTS INCLUDE: *Turbojet Engine Temperature Control Amplifiers • Pressure Gauges Pressure Switches • Thermal Switches • Hydraulic Valves • Jet Engine Afterburner Control Systems.*

CONSOLIDATED CONTROLS CORP... BETHEL, CONN., INGLEWOOD, CALIF.
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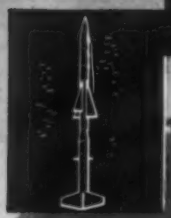
RELIABILITY, ACCURACY IN

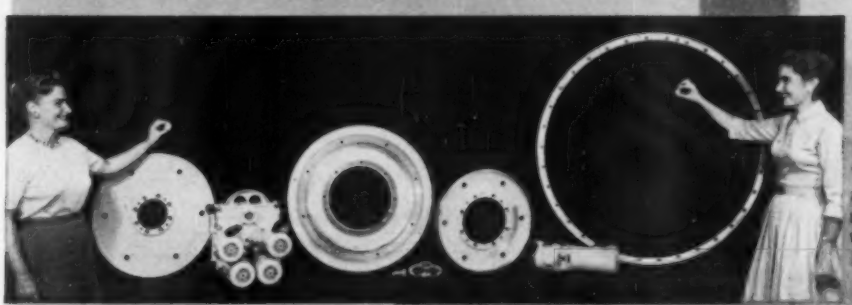
Nike Tracking Antenna Control Gearing... by Western Gear

Four motor powered gear drive



The control gears and actuators provided by Western Gear for the U.S Army tracker installations have for years provided nothing less than 100% reliability. In the intervening years Western Gear's engineering skill has moved forward with substantial progress in devising systems of advanced tracking techniques which will be "Tomorrow's Headline Story."

Western Gear's painstaking craftsmanship and technical production skill make us the logical source for the design and manufacture of missile components and complete systems . . . and blending of tomorrow's electronic marvels with the experience gained in 69 years of leadership in the mechanical power transmission field.



Here are the Western Gear control gears and actuators used in the missile tracking radar . . . some the size of your finger nail, some 4 feet in diameter.

All respond instantly, accurately regardless of weather conditions, WITH 100% RELIABILITY!

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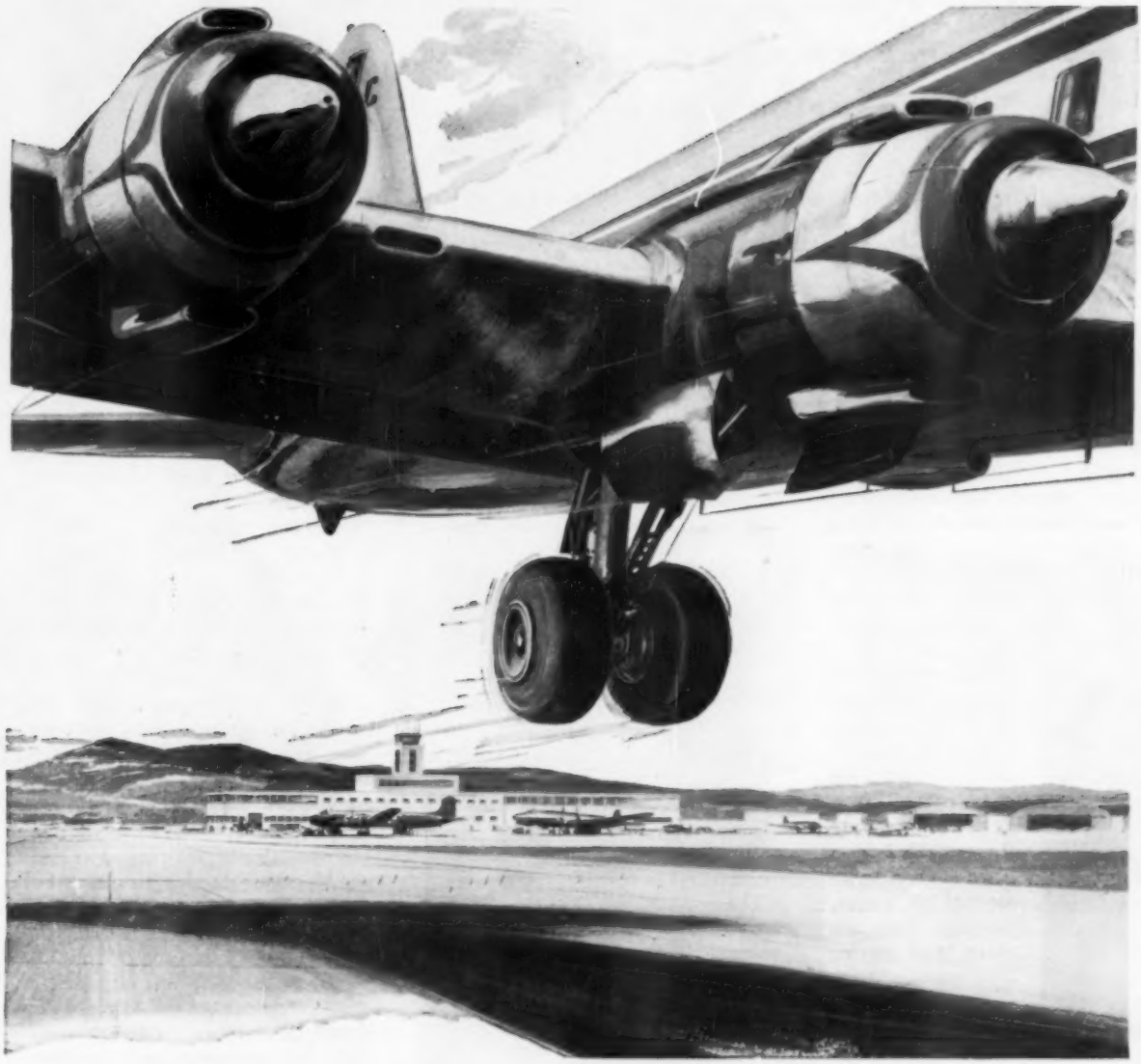

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Winged Couriers of Industry

by **HERB FISHER**, *international aviation authority, veteran test pilot, author*

Backbone of civil aviation's growth to 100,000 aircraft — a 400 per cent increase in 15 years — is "strictly business... business before pleasure."

Of civil aviation's *private* flying fleet alone, which is 44 times larger than the 1,500-plane scheduled airline fleet, some 25,000 aircraft are "flying conference rooms," *winged couriers of industry.*

Down to earth . . . Mike Murphy, Co-pilot Dick Owens (l/r) chart route to Guatemala.

Business flying is big business, expanding at a rate far outstripping that of commercial and pleasure flying. With one factory in three located in a small town off commercial air routes, business fleets are more than paying their way.

I've found few firms with business fleets and aviation departments comparable in size, scope and efficiency to that of the Ohio Oil Company.

This company — with world-wide operations embracing exploration and production, supply and transportation, refining and marketing — is a natural for business flying. The 14th largest domestic crude oil producer among 12,000 concerns, Ohio Oil must integrate by fast flight a scattered domestic operation ranging from Texas to Canada, and a foreign exploration program stretching to remote corners of the earth.

Rugged duty . . . Champion-equipped Tri-Pacer flies Illinois pipeline patrol.

Ohio Oil operates 23 aircraft, has 32 full-time pilots and co-pilots, nine skilled mechanics, and owns and maintains a modern airport at Findlay, Ohio, equipped to handle all types of aircraft; runways alone compare with the longest in the U.S.

Heading the company's 48 member Aviation Department is an old friend of mine from barnstorming days — one Michael Murphy, dean of old-time stunt men, a decorated precision pilot and an aviation legend. Mike set up Ohio Oil's Aviation Department in 1945, after an Air Force career as lieutenant colonel in charge of glider fleets for General "Hap" Arnold.

Few U.S. corporations own and operate an airport with such *complete* hangar and shop facilities for maintenance, overhaul, and even conversion of its varied aircraft, as does Ohio Oil. And in every detail, this operation is efficiency at its best.

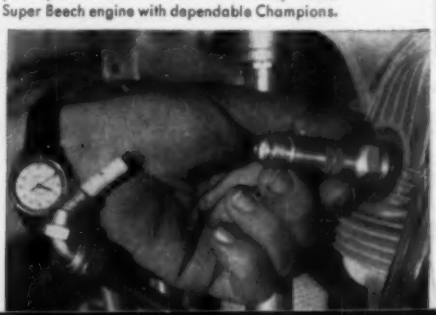
"Management wants nothing but the very finest care given their planes aloft as well as on the ground," Mike told me. "We're directed to use only the very best in parts and equipment — thoroughly tested by us to meet our top standards for maximum safe performance in all operating extremes.

"That's why we've used Champion Spark Plugs, for example, for 10 years. We've found them tops in performance and dependability."

Ohio Oil aircraft, too, are selected for specific jobs — Super Ventura, DC-3's and C-47's for long hauls to far-flung points not serviced by

Days away, once . . . Remote oil field is but few hours from Findlay headquarters via Champion-fired Bonanza business craft.

In good hands . . . Skilled technician assures peak performance of Pratt & Whitney R-985 Super Beech engine with dependable Champions.



Top men, top assignment, top equipment . . . "Amazing what the *right* spark plug can do," Mike Murphy (c) tells Ass't Aviation Mgr. Earl Bauer, Ventura Pilot Dick Yoakam (l/r), and Co-pilot-Mechanic Mac Powell (rear). Ohio Oil experimented with other spark plugs through the years, always returned to Champions.

airlines, or for large groups wishing to hold conferences en route; Piper Tri-Pacers for pipeline patrol; Twin Beeches, a Twin Bonanza, a Travelair and Bonanzas for heavier loads and feeder service to airline terminals; DeHavilland Beavers and Cessnas for general duty.

"With our world-wide operation, traveling itself could be a full-time occupation for many of our personnel if we didn't have our own air fleet," Mike said. "Management indicates that, without a business fleet, we would need considerably more high-salaried specialists and executives – and these are hard to come by. It's difficult to estimate the monetary value of increased production hours resulting from tremendously reduced travel hours."

A case in point: For Ohio Oil executives to get in one day's work at the company's Robinson, Ill., refinery, two days are spent in round-trip land travel. Champion-fired business aircraft, however, provide three-hour round-trip commuter service, enabling one man to compress three days in one.

"We're not competing with the airlines," Mike said. "Actually, we bring them to our front door. We shuttle our executives to commercial terminals when they're en route to destinations served by airlines."

New feathers for old eagles . . . Veteran pilots like Tom McFarland get constant refresher training in new equipment and procedures. Link operator is Pilot Dick Carpenter.

Aerial pipeline patrol certainly pays for itself, too, Mike told me. A Tri-Pacer pilot covers in one day 550 miles of Ohio Oil's 3,300-mile pipeline system. Walking inspectors cover but 10 miles a day.

This daily flying at extremely low altitudes calls for intense pilot concentration – split-second attention to various details of plane performance, terrain, turbulence. The pilot can take no chances of engine failure. Such rugged duty makes it mandatory, then, that the vital heart of the pipeline patrol plane be fired to life day after day by Champions.

Ohio Oil maintains small airports in remote exploration areas of South America and Africa. At Ohio Oil's Oasis Oil Co. of Libya, for example, a C-47, Beaver and Cessna carry supplies and personnel into regions previously accessible only by many days of camel caravan.

Here, too, Champions assure safe flight over trackless wilds, where engine trouble far from an airport might mean the end . . .

At Findlay headquarters I saw flight crews – all in white dress shirts–handling passenger baggage,

Fast, flexible . . . Egyptian C-47 and helicopter help solve time, distance problems—mandatory for integrating and supplying Ohio Oil's far-flung foreign operations.

gassing planes, doing administrative work, getting weather reports, mapping precise routes over back country, doing custodial work in plane interiors, checking and ordering replacement parts, performing as all-around mechanics, designing their own executive plane interior equipment, sewing fabric and doing carpentry on interior woodwork installations – literally doing *everything* themselves–plus flying.

"You'd have to screen thousands of pilots and mechanics to find any as qualified as ours," Mike told me. "Our men must be specialists in not one field but several."

It's a real tribute to Mike's management and experience – along with the performance of pilots, maintenance crews and aircraft equipment, such as Champions–for Ohio Oil to have been honored by the N.B.A.A. for a perfect safety record . . . 33,000,000 accident-free passenger miles.

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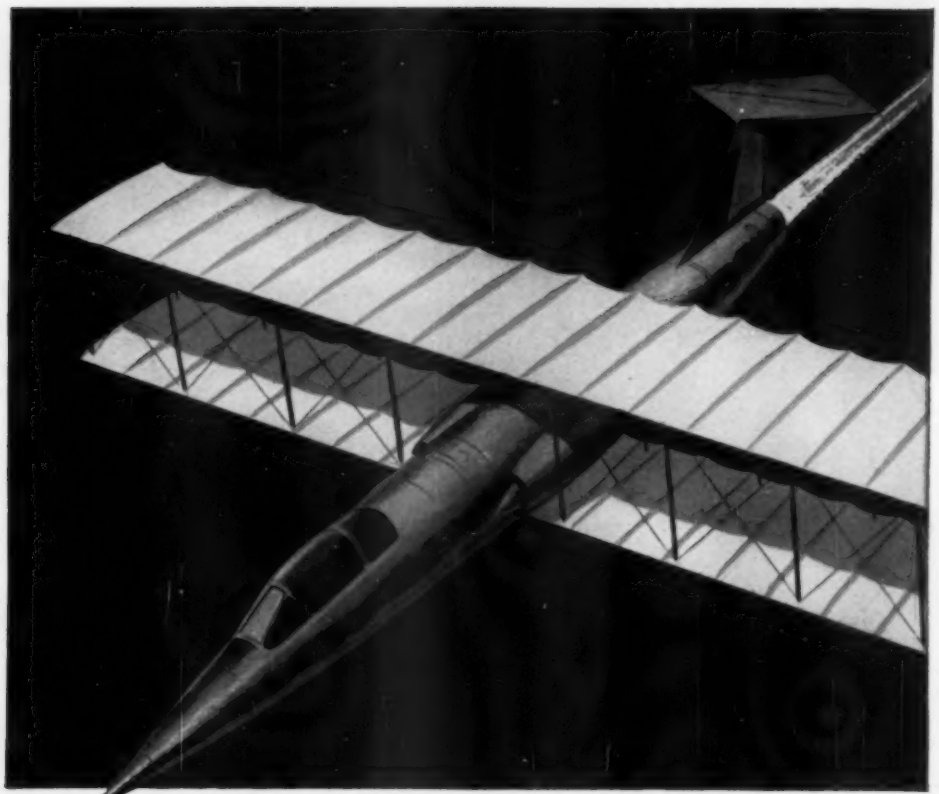

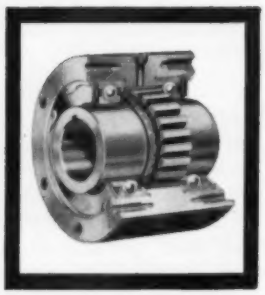

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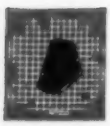
Take clutches, for example—in aircraft plants throughout the country, modern Formsprag clutches have replaced old-fashioned ratchet and pawl mechanisms as well as their roller-type successors.

This widespread change to Formsprag among designers is, in itself, proof of superiority. Consider, too, Formsprag's other advantages: the patented sprag principle, which allows a Formsprag clutch to deliver more torque per cubic inch of displacement than any other power transmission unit available; ease of installation; and low maintenance cost. An additional feature of its modern design is simplicity, making prototype testing economical.



Remember, too, when it's time to replace your present power transmission—don't *just* replace—modernize with Formsprag. For complete information: send for a copy of the newest Formsprag catalog.

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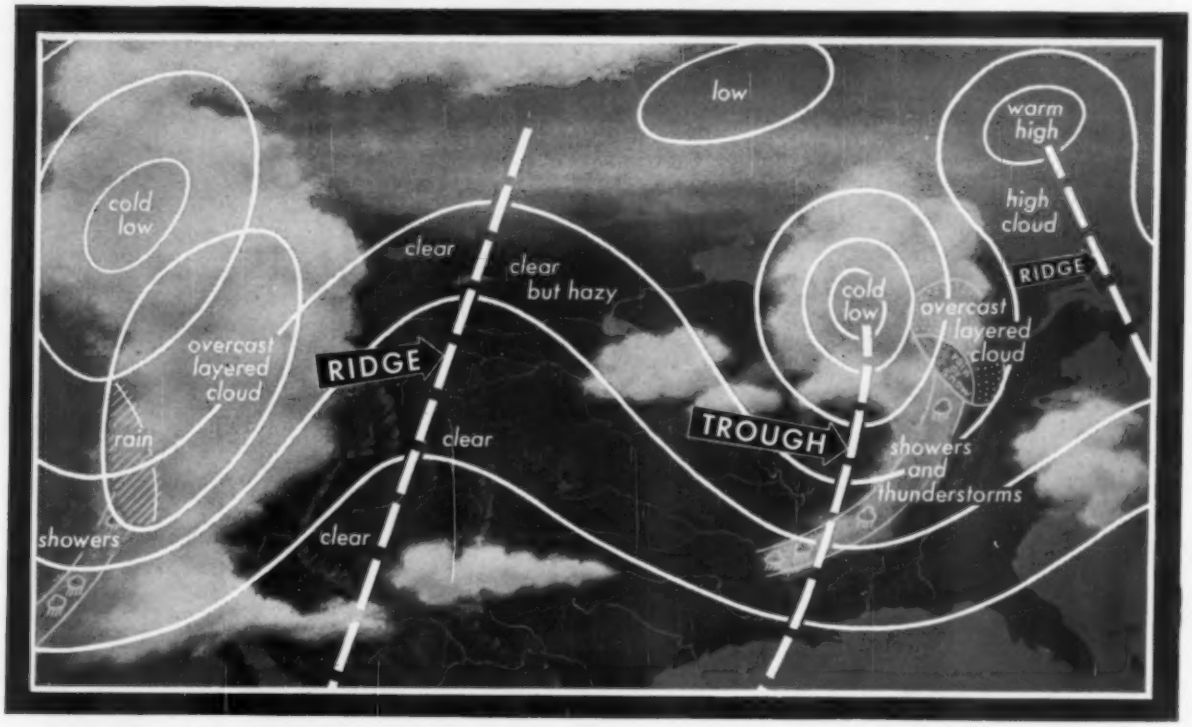

CIRCULATION PATTERNS

Clockwise circulation of air around High Pressure areas and counter-clockwise flow around Lows in the northern hemisphere are well known to most pilots. However, there are some lesser-known features of Highs and Lows which have become apparent with the progress made in upper air analysis.

Warm Highs—Extend to levels above 10,000 ft. with temperatures generally warmer than Standard Atmosphere. As this type of High extends farther aloft, it often assumes an elliptical shape with major axis lying N/S to form a *Ridge*. This Ridge normally moves very slowly, blocking eastward movement of weather systems at lower levels, often causing prolonged periods of fair or rainy weather in adjacent areas. Weather in warm Highs is usually dry, fair and often hazy.

Cold Lows—Extend to high levels with temperatures generally colder than Standard Atmosphere. Their normal eastward movement slows until sometimes the center aloft becomes stationary or even retrogrades westward. This is called a Cold Low because of concentration of cold temperatures near the center. V-shaped elongation of these Lows toward the south is referred to as a *Trough* and marks region of wind shift and possible clear air turbulence.

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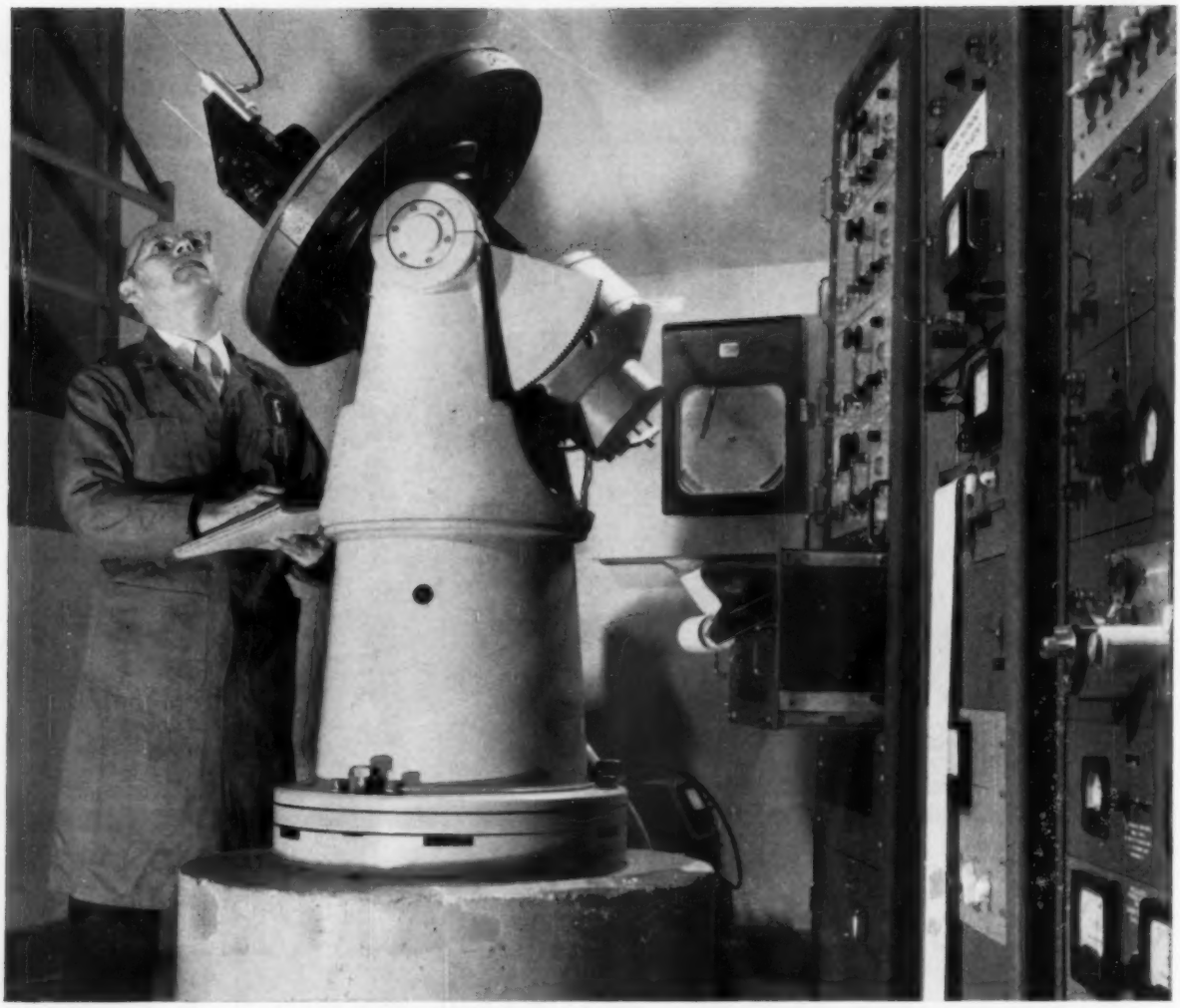

Ford Instrument Co. Engineer checks air-bearing gyro for angular drift on equatorial test stand. Test can show up drift rates as low as one revolution in 40 years. Tests like this . . .

helped Army put "Explorer" into orbit

Some of Ford Instrument's current or recent programs include:

Inertial guidance systems . . . including Redstone and Jupiter

Missile launching and control order computers

Navigational and mission control systems and computers

Analog and digital computer systems

Fuzing, arming and other warhead control equipment

Plotting equipment

Nuclear systems and controls

Gunfire controls

Drone controls

A special guidance system for the Jupiter C, developed by the Army Ballistic Missile Agency, was used to launch the first U. S. artificial satellite into space.

Many components of this system were provided by Ford Instrument Co., prime contractor for both the "standard" U. S. Army Redstone and Jupiter guidance systems.

The fabulously-equipped, fantastically-clean gyro lab (above) is only a small part of the advanced research and development facilities available at Ford Instrument Co. They're used to create and produce the incredibly accurate control systems called for by modern technology in both government and industry.

And Ford Instrument's large-scale precision manufacturing facilities can turn even the most critical system requirements into working "hardware" on a quantity-production basis. Our Liaison Engineers are at your service to discuss your system requirements. a.c

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COVER: U. S. Army's newest ballistic guided missile, the Sergeant, is fired from its mobile erector launcher at White Sands Proving Ground, N. M. Missile is 30 ft. long and has highly accurate guidance system reported invulnerable to any known means of enemy countermeasures. Sergeant is successor to Army Corporal and was developed by Jet Propulsion Laboratory, California Institute of Technology. Sperry Gyroscope Co. is responsible for production of complete missile system. Sergeant rocket motor uses solid propellant fuel as part of design philosophy of extreme field mobility.

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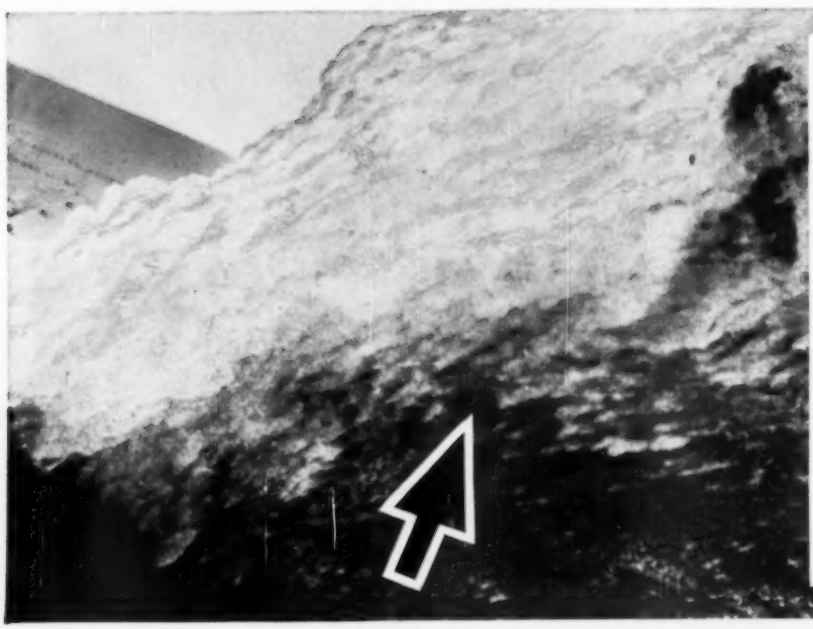
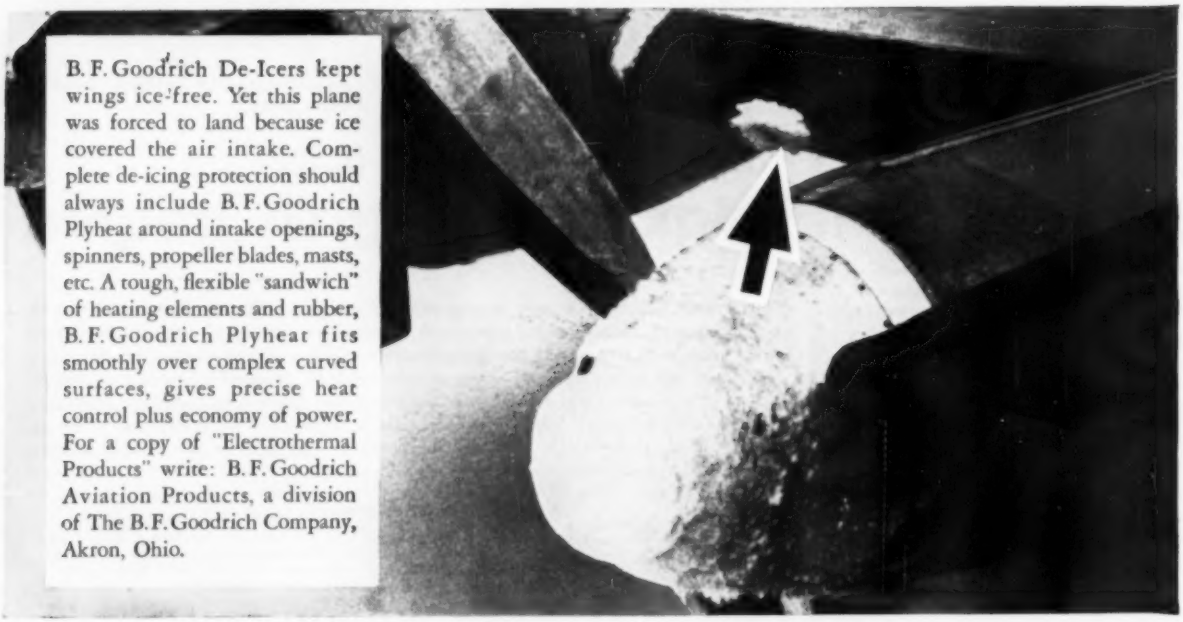


Ice means trouble. Even a thin layer can interfere with the handling characteristics of a plane. And a heavy build-up like the one shown here can add hundreds of pounds of dead weight. But with B.F.Goodrich Pneumatic De-Icers on leading edges, a pilot can fly through the worst icing conditions safely. When ice begins to form he merely flips a switch. Small tubes inflate and deflate alternately—snap off even rapid accretions of ice simply, dependably. For more information on B.F.Goodrich Pneumatic De-Icers, send for bulletin AD-301.

B. F. Goodrich Plyheat could have prevented this



B. F. Goodrich De-Icers kept wings ice-free. Yet this plane was forced to land because ice covered the air intake. Complete de-icing protection should always include B. F. Goodrich Plyheat around intake openings, spinners, propeller blades, masts, etc. A tough, flexible "sandwich" of heating elements and rubber, B. F. Goodrich Plyheat fits smoothly over complex curved surfaces, gives precise heat control plus economy of power. For a copy of "Electrothermal Products" write: B. F. Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.

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EDITORIAL

A Sound Space Program

After a winter of ferment and indecision, the first days of spring have produced a series of actions that promise to put the military weapons development program in general and the space exploration program in particular on a sound basis for accelerated action. We would be less than human if we neglected the opportunity to point with a little pride to the fact that each of these recent decisions by the White House and Pentagon followed the courses we hammered for editorially in recent months.

They are:

• **Presidential recommendation** of the National Advisory Committee for Aeronautics as the nucleus of the new National Aeronautics and Space Agency to spearhead the U.S. drive to usefully explore space. Our editorial, "NACA, the Logical Space Agency" (AW Feb. 3, p. 21) was widely used in the congressional debate on this subject in both House and Senate.

• **Army decision** to switch from its arsenal concept of missile development in awarding a weapon system type development contract to the Martin Co. for its new solid fueled Pershing ballistic missile. We assailed the Army arsenal development concept in a series of editorials last fall, "Missile Misinformation" (AW Sept. 9, p. 21), "The Missile Industry Myth" (AW Sept. 16, p. 21), "Who Really Develops Missiles" (AW Sept. 23, p. 21) and "Perspective on Missiles" (AW Sept. 30, p. 21).

In these editorials, we argued that the arsenal concept was hopelessly inadequate to cope with modern weapons development problems. We warned that the Army was doomed to technical inferiority until it modernized its development concepts. We strongly suspect that the rude shocks experienced by top-level Army leaders when the Douglas Thor and the Redstone Arsenal Jupiter were evaluated side by side last winter convinced them of the wisdom of the weapon system concept and also stimulated Wernher von Braun's bitter public denunciation of it in Los Angeles recently.

• **Presidential authorization** for a lunar probe launchings by USAF and Army. This announcement last week confirmed an exclusive AVIATION WEEK story in our Jan. 20 issue, page 26, detailing the use of the Douglas Thor as a first stage plus Vanguard second and a newly developed third stage. It is certainly a wise decision to proceed with the initial space exploratory projects that can be implemented in the immediate future using adaptations of existing hardware rather than allow the entire space program to stagnate while the administrative re-organizations required are being thrashed out.

It is apparent that the addition of Dr. James Killian, Jr., president of the Massachusetts Institute of Technology, to the President's staff as his scientific advisor has had a salutary effect in stirring the executive branch of the government into bolder and more imaginative action than was apparent during the first six post-Sputnik months. The President's space agency proposals also recognized the fact, often deliberately overlooked by the "lunatic fringe of space cadets," that the exploration of space must include the problems of getting in and out of the earth's atmospheric envelope safely and efficiently.

It would serve little purpose here to repeat the details of our strong endorsement of NACA for the space research role in the Feb. 3 editorial "NACA, the Logical Space Agency." We strongly support the President's space agency proposals and urgently recommend that the leaders of the aviation industry and the scientific communities associated with aeronautical development and its expanding technologies get behind this proposal and give it firm and unequivocal support when the subject is debated before the appropriate congressional committees.

It is fortunate and a good example of the flexibility of the legislative branch of the government that both House and Senate have organized special space committees to consider the host of new problems raised by this endeavor. The men serving on these committees have been well selected from a background of military and fiscal experience on Capitol Hill and should be capable of better consideration of space problems than any of the traditional legislative groups.

Inevitably, some opposition will develop to the President's space agency proposal although there is no indication that it will be along strictly political lines. Rather it is likely to come from individuals who had alternate proposals on how to best handle the problem.

Perhaps the knottiest problems to be solved by the new space agency will not be technical but in working out a sound relationship with the military services interested in space weapons and the industry that has traditionally shouldered the major development load. But perhaps the strongest argument in giving NACA the new space job is its solid record of more than 40 years of handling these complex relationships on an effective basis through the fantastic technological revolutions that brought the airplane from spruce, canvas and baling wire to the stainless steel, 2,000 mph. piloted vehicles of today that already have carried man to the edge of outer space.

—Robert Hotz

MISSILE COMPONENTS Bulova safety and arming systems protect ground, air and sea crews from load to launch, then take over in flight. Safety factor of one in a million is specified and reliably delivered by Bulova's precision production facilities. Powder-driven gyros and fuzing systems are among other Bulova developments for 18 key missiles.

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INFRA-RED COMPONENTS Bulova infra-red cells are designed to unerringly guide Sidewinders to target. Bulova-improved production processes increase yield and product reliability. Other infra-red developments include filters, reticles and thermistor bolometers, as well as advanced research in mosaic and lead selenide cells.

PHOTOGRAPHIC SYSTEMS Bulova's new high performance 70mm recon-camera features 8 frame/sec. and pulse operation . . . vibration-free exposures to 1/4000 sec. From the smallest 16mm gun camera ever built to units of 9x18" format size, Bulova developments include optical, data recording and instrumentation, and special sequence cameras.

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In the Front Office

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Jack S. Warshauer, executive vice president and chief executive officer, Summers Gyroscope Co., Santa Monica, Calif. Also: **Robert E. Peck**, vice president-operations, and **J. M. Wright**, vice president-customer relations.

Alvin L. Schoellerman, executive vice president and a director, Altamil Corp., El Segundo, Calif.

George W. Chane, vice president-management engineering, Radio Corporation of America, New York, N. Y.

Dr. Robert M. Bowie, vice president, Sylvania Research Laboratories, division of Sylvania Electric Products, Inc., New York, N. Y. Also: **Melvin E. Lowe**, manager, Missile Systems Laboratory, Sylvania Electronic Systems.

John E. Muhlfeld, vice president-sales, Air Express International Corp., New York, N. Y.

Louis O. Mitchell, a vice president, Trans-Sonics, Inc., Burlington, Mass.

Read Q. Chalfant, assistant vice president-traffic and sales, Capital Airlines, Inc. Also: **Robert L. West**, director of advertising.

Brig. Gen. Richard W. Hayward (USMC, ret.), has joined the staff of Aerojet-General Corp., Azusa, Calif. Gen. Hayward will assist with the planning and design of the Pacific Missile Range.

Maj. Gen. Leighton I. Davis will become Deputy Commander for Research and Development, Headquarters, Air Research and Development Command, Andrews Air Force Base, Md. **Brig. Gen. Daniel E. Hooks** will succeed Gen. Davis as Commanding General, Air Force Missile Development Center, Holloman AFB, N. M.

Honors and Elections

Brig. Gen. M. S. White, Director of Medical Staffing and Education for the Surgeon General, USAF, has been elected president of the Aero Medical Assn., Washington, D. C.

Dr. Charles C. Lauritsen, Professor of Physics at the California Institute of Technology, has received the second annual Capt. Robert Dexter Conrad Award, established by the Office of Naval Research, for "outstanding contributions to the Navy's research and development program in the field of rockets, nuclear physics and tactical operations . . ."

Mrs. Rita C. Sagalyn has been selected as Guenter Loeser Memorial Lecturer for 1958 by the Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass.

A. Wilson Laird, vice president-advanced planning and government relations for The New York Air Brake Co., has been appointed to the Board of Governors of the Aircraft Industries Assn.

C. J. Reese, president of Continental Motors Corp., has been appointed to the Industry Consulting Committee of the National Advisory Committee for Aeronautics.

(*Continued on p. 94*)

INDUSTRY OBSERVER

► Martin Denver's Titan intercontinental ballistic missile is a three-stage, three-engine vehicle. First stage has two engines, second stage a single engine, third stage none. However, fourth engine can be installed in the third stage at a later date if necessary. Reason for separating the second and third stages, although the third is unpowered, is because re-entry problems would be encountered if a large second stage—about 36 ft. long—remained attached to the nose section. Separation of second and third stages is accomplished by venting residual liquid oxygen from the second stage supply tanks at a pressure of about 35-40 psi. through two vent valves. Valves are placed diametrically opposite each other at the outer edge of the front of the second stage and are canted outward several degrees from the missile's centerline. Force of liquid oxygen escaping through vent valves gradually slows down the second stage and gently separates it.

► Novel guidance technique in which the missile responds directly to voice commands radioed by a human operator watching its flight on a radar scope has been developed by Martin's Orlando Division. Technique, possibly developed for use with Martin's Bullpup air-to-surface Navy missile, relies upon the fact that certain vowel and vowel-like sounds are almost identical for all male voices. Development has reached the stage where guidance receiver can recognize at least four different commands from all male voices tested.

► Major improvement in accuracy of inertial quality gyros and guidance systems, representing perhaps as much as a 10-fold gain plus improved reliability and life, is expected during the coming year as a result of new materials and techniques being developed for manufacture of precision bearings.

► Office of Naval Research plans to send a 16-in. telescope to an altitude of 100,000 ft. in a balloon for astronomical observations above the earth's atmosphere. Pictures of the sightings will be transmitted back via television. The relatively small telescope, free of atmospheric haze, is expected to produce results equivalent to the 200-in. Mt. Palomar telescope.

► North American Hound Dog electronic countermeasures missile to be used by the Boeing B-52 and McDonnell's twin-engine all-weather fighter-attack bomber will use variable inlet geometry. Marquardt Aircraft Co., which also built the inlet controls for the North American F-107, is building the controls for these two projects. First F4H, powered by General Electric J79s, is scheduled to roll out this month. Design speed is Mach 2.

► Air Force, following Army's successful experiments with re-entry of the Jupiter nose cone, is looking toward plastics which ablate (are removed) at Mach 2 and 3 re-entry speeds as a possible solution for problems confronting second-generation ballistic nose cones. Plastics being used are made of organic materials. Cone will begin ablating evenly at temperatures of approximately 800F.

► Manned Space Flight Division has been established at Air Force Flight Test Center, Edwards AFB, Calif. Group will work in areas of pilot flight controls and displays in addition to other aspects of manned space flight.

► Prototype coleopter annular-wing test vehicle developed by the French engine firm Snecma to Zborowski patents is now being assembled. Aircraft will be subsonic and be flight tested in all flight regimes between vertical ascent and descent and horizontal flight. Snecma is pushing ramjet development for supersonic designs to follow this prototype.

► Nord SS-11 missile has been installed on the Dassault Flamant, Sud Aviation's Alouette helicopter and Chance Vought Corsair for operational use against ground targets. Wire-controlled missile is a development of the basic SS-10 anti-tank missile recently sold to the U. S. Seventh Army in Germany.

► Navy's Polaris fleet ballistic missile will carry a megaton warhead.

THE PRODUCTS OF THE MIND

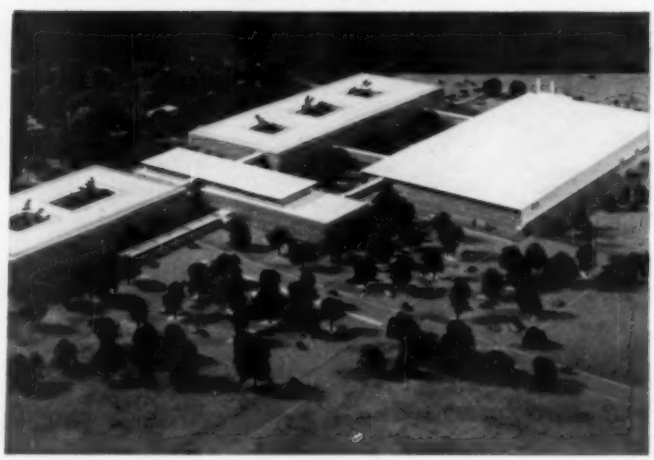
The world we live in is in large part the product of the scientific thought and accomplishment of the past, translated into engineering achievements. Whether we continue to go forward depends on whether the scientific curiosity, the imagination, the careful thought, and the logical analysis of the past, upon which today's technical achievements were built, can exist and flourish in the environment of the new world.

At Avco Research and Advanced Development Division, and at other places in the free world, an atmosphere exists in which the inquiring mind may live and create. We have the technical assistance and the facilities by which ideas are converted into concrete accomplishments. Many things have been done, and infinitely more remain to be done—the world of scientific thought is unlimited and promising. From the products of the mind will come the technical world of tomorrow.

Sidney L. Simon

Dr. Sidney L. Simon
Assistant to the President

Dr. Sidney L. Simon



Pictured above is our new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion this year, the ultramodern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

Avco Research and Advanced Development Division now offers unusual and exciting career opportunities for exceptionally qualified and forward-looking scientists and engineers.

Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.

AVCO
Research & Advanced Development

Washington Roundup

BuAer Overdraws

Navy's Bureau of Aeronautics, faced with the prospect of overdrawing its Fiscal 1958 funds by several hundred million dollars at present spending levels, is cutting back on progress payments to contractors and keeping a tight rein on expenditures in general. Primary reason for the funds shortage apparently was the bureau's failure to evaluate accurately the impact its demands for industry to cut lead times would have on expenditures. In some instances, the bureau is asking its contractors to accept relatively small progress payments until the end of the fiscal year. Some small contractors won't receive any progress payments until after July 1. Still other firms are being asked to defer billings until the beginning of new fiscal year.

USAF Record Splurge

Watch for the Air Force to blossom with a splurge of record breaking flights aimed at bringing all piloted flight records to roost under its banner. Attempt of a KC-135 tanker to fly nonstop from Tokyo to Madrid, getting a major boost from the high altitude jet stream, will be the first effort aimed at shattering the Navy's 11,236 mi. nonstop record now on the books and set by the Lockheed P2V Truculent Turtle in 1946. Lockheed F-104 will attempt a world speed record boost over the 1,207.6 mph. mark set last fall by the McDonnell F-101 and try to snatch the altitude record back from the British. Recognized altitude record for aircraft is now 70,308 ft. set by an English Electric Canberra powered by Bristol Olympus engines.

Electronics Buying

Development of a federal airways navigation system will be pushed to stimulate the electronics industry.

Legislation asked by the President and rushed through Congress last week authorizes Civil Aeronautics Administration to purchase up to $50 million in air navigation equipment, largely electronics, in the next 80 days. This is part of the $102 million for air navigation equipment originally programmed for Fiscal 1959 which begins July 1.

The President and the Appropriations Committees frankly explained that the reason for the legislation authorizing civilian agencies to push forward their equipment buying programs is "to stimulate business activity and employment." The measure would authorize Airways Modernization Board to promptly launch a $4 million buying program.

Congressional Outlook

Here are developments to expect from Congress:

• **Procurement investigation.** House Appropriations Committee is making an investigation of military procurement practices in connection with consideration of the Fiscal 1959 defense budget.

• **Airports.** Senate Commerce Committee will open hearings April 14 on legislation to make an "emergency" $75 million in federal funds immediately available for airport construction. The measure also would increase the federal allocation, starting with Fiscal 1960, from the present $63 million annually to $100 million. With 50% matching funds from local communities, this would mean an annual development program of $200 million.

• **Military Air Transport Service.** Senate Commerce Committee will start hearings on MATS competition with commercial air carriers Apr. 16.

• **Small Business.** A Senate Small Business Subcommittee has scheduled hearings April 15-17 on defense purchasing policy as it affects small firms in the fields of guided missiles, rocketry and outer space exploration. Defense witnesses include William Holaday, Defense Department director of guided missiles; Roy W. Johnson, director of the Advance Research Projects Agency, and Maj. Gen. Bernard A. Schreiver, commander of USAF's Ballistic Missile Division.

Killian's Secrecy

Rep. John Moss (D.-Calif.), chairman of the House Government Information Subcommittee, is challenging the reasons given by Dr. James Killian, the President's scientific adviser, for keeping tight secrecy on the names of the special advisory panels he establishes from time to time to review controversial defense projects. Dr. Killian explained to Moss:

"Most of the panels are temporary in nature, going out of existence once they have made their report and recommendations. To identify the panels and their membership would be to disclose which problems and substantive areas—some of which are of a highly sensitive nature—are of current interest to the . . . President."

In response, Moss has asked Dr. Killian whether the President or Killian made the decision to withhold the information. Moss added: "I also would like to know whether it is your personal conviction, as a scientist as well as a government official, that release of information on the composition of advisory panels would constitute a threat to the public interest or national security?"

New Local Service Interest

Guaranteed loan and capital gains bills recently passed by Congress have sparked a new interest in local service carriers among aircraft and engine manufacturers. The new sources of money resulting from these bills, coupled with an urgent need by local service airlines to replace the uneconomical DC-3 with more modern equipment, have suddenly established the small carriers as significant potential customers. Meeting this week at Las Vegas, Nev., of the Assn. of Local and Territorial Airlines is attracting two major engine manufacturers and four aircraft companies who will display their products to airline heads and officials. Most carriers realize that benefits of the capital gains bill will be insignificant unless DC-3 fleets are turned over immediately before the market is glutted with second-hand transports.

Retirement Penalty

Members of House Armed Services Committee are considering introducing legislation that would penalize members of the armed services educated at government expense who retire at an early age. Rep. Leslie Arends (R.-Ill.), ranking minority member, declared at a hearing that the need for it "has been emphasized by the retirement of certain officers in recent months."

Members are also considering a measure which would require academy graduates to serve a specified period of time in the military services.

—Washington staff

Space Technology

Air Force Plans Manned Orbit for 1959

Gen. LeMay seeks funds to support ARDC program that would put primary emphasis on human factors.

Washington—Support for a crash program to shoot a manned recoverable capsule-satellite into orbit around the earth is being sought from Department of Defense by top Air Force planners.

Gen. Curtis E. LeMay, Air Force vice-chief of staff, favors the project and is shaking the funding trees for the money—$170 million—to support the program, which is known as Man-in-Space Project and targeted to achieve its aim before the end of 1959. No official go-ahead will be issued until funds are pinpointed.

ARDC as Monitor

USAF's Air Research and Development Command headquarters would monitor the program. Because primary emphasis will be upon resolution of human factors problems involved in orbit and re-entry, the program would be spearheaded by Brig. Gen. Don Flickinger, director of ARDC's Life Sciences Division, teamed with Maj. Gen. Victor R. Haugen, assistant deputy ARDC commander for weapon systems.

Difference between this project and the scheduled North American X-15 out-of-atmosphere flight is that the latter will follow a relatively short up-and-down path between fairly close bases (AW Feb. 3, p. 26).

Pattern for Future

The manned capsule, on the other hand, would orbit the earth a number of times, then re-enter under conditions that would lead to patterns for future out-of-atmosphere operational techniques.

Project has been included in ARDC's planning for some time now, punctuated by peaks and valleys of enthusiasm.

Complete presentation was made late last month, including details of concept and operation, to Gen. LeMay for his consideration. The Man-in-Space Project envisions these highlights:

- **Capsule-satellite will be put** into orbit as close to earth as feasible, probably at a distance of less than 200 mi. Aim will be to achieve an orbital path as close to circular as possible to avoid the great distances involved in elliptical orbits and to better control re-entry timing and conditions.
- **Time spent orbiting** may range as long as 48 hr. depending upon operational conditions, the higher value being the limit related to survival of the subject in this particular program.
- **One of the prime** considerations would be to determine whether man can perform basic functions for relatively extended time periods under operational conditions in actual out-of-atmosphere environment. Aspects of weightlessness and its relation to human functions will come in for extensive analysis.
- **Payload of instruments,** including television camera and possibly other scanning systems, will be incorporated in the capsule to augment the human payload.

President Asks Sweeping Defense Reorganization

Washington—Sweeping revision of the U. S. defense organization that would concentrate operational and financial control with the Defense Secretary and reduce the three services to essentially logistics and training agencies was proposed last week by President Eisenhower.

The proposals run directly counter to bi-partisan bills already before Congress that would strengthen the roles of the Joint Chiefs of Staff and the three service secretaries. The Eisenhower recommendations to Congress would reduce the authority of the joint chiefs, who would relinquish much of their command functions, and of the service secretaries who would be "relieved of direct responsibility for military operations."

Defense Secretary also would be given broad authority and control over military research and development activities with the assistance of a new Director of Defense Research and Engineering who would replace the present Assistant Secretary of Defense for Research and Engineering. The new director would "rank immediately after the service secretaries and above the Defense assistant secretaries. His salary would equal that of the three service secretaries.

Here is the President's program as outlined in his message to Congress:

- Strategic planning and basic operational direction. These roles should rest "not with the separate services but directly with the Secretary of Defense and his operational advisers, the Joint Chiefs of Staff."
- Unified operational commands. "I intend that . . . our operational forces be organized into truly unified commands. . . . They will be in the Department of Defense but separate from the military departments."
- Chain of command. "I consider this (present) chain of command cumbersome. . . . Accordingly, I have directed the Secretary of Defense to discontinue the use of military departments as executive agents for unified commands."
- Joint Chiefs of Staff. "I am . . . issuing instructions that their function is to advise and assist the Secretary of Defense . . . and not to perform any of their duties independently of the Secretary's direction."

The President also asked Congress to change present law to allow each chief to delegate major portions of his service responsibilities to his vice chief to allow him to make his staff job his principal duty.

- Service secretaries. The secretaries, relieved of direct operational responsibility, "will be better able to assist the Secretary of Defense in managing the vast administrative, training and logistics functions of the Defense Department."
- Research and development. The Defense Secretary's control over organization and funds should be "complete and unchallengeable." Most research activities already under way would continue within the military departments. New projects that require "central direction" would go to the Defense Secretary.
- Financial control. Appropriations should be made in "such fashion as to provide the Secretary of Defense adequate authority and flexibility to discharge his heavy responsibilities. This need is particularly acute in respect to his powers of strategic planning and operational direction."
- Promotions and transfers. Before officers advance beyond the two-star level, they must establish their ability to work objectively, "without extreme service partisanship." The President will consider nominations above the two-star level "only on recommendations of the Secretary of Defense." The Secretary also should be authorized to transfer officers between services, "primarily in technical fields."

• **Atlas, Titan or Thor** ballistic missile propulsion components might be used as the booster stage, although present plans pinpoint no particular rocket powerplants. Second stage would be another off-the-shelf rocket, and a third stage might require some special modification or development. Liquid propellant powerplants probably would be selected because it is felt G-forces could be controlled more precisely than with solid propellant rockets.

• **Launching would be from** Air Force's Missile Test Center at Cape Canaveral, Fla., or from Navy's National Pacific Missile Test Range at Pt. Mugu, Calif.

• **Probably two manned** capsule systems would be required as standby units, each ready to be substituted for the original mounted capsule if countdown were interrupted and shoot delayed appreciably due to last-minute difficulties. This approach probably would be required because it might not be feasible to retain the subject, scheduled for the flight, for a prolonged period under the sealed condition necessary for out-of-atmosphere existence.

• **Retrorockets would be used** for slow-up during the re-entry phase. Full control of the dynamics and heat problems involved in capsule re-entry have not been fully solved. A wide variety of devices are being studied to bring terminal velocity to a livable level including metal parachutes.

• **No research breakthroughs,** or drastically new materials or insulation will be necessary to bring the various aspects of the program into readiness for the ultimate firing phase, but numerous refinements will be required in many areas.

Capsule is not now available in the form that would be needed, but development of this unit with characteristics sufficient to ensure survival of the enclosed observer subject during orbit and re-entry is not considered a very difficult task.

• **ARDC's Ballistic Missile Division** headed by Maj. Gen. Bernard Schriever also would support this Man-in-Space program. BMD's function would be to feed to ARDC headquarters results of theoretical studies and other data relating to re-entry factors, including lift and drag evaluations specifically related to the capsule.

• **Air Force candidates** to ride the capsule will be on a volunteer basis. Indications are that no difficulty will be encountered in obtaining enough of these volunteers to form a pool from which to screen the three to six finalists who will be involved as the subject for an orbital shoot plus standbys. Rigid physical requirements and participation in specially planned training course would be required from all of the volunteers.

Wizard Reactivated

Washington—Air Force Wizard anti-missile weapon system was reactivated last week by a directive from Defense Department missile czar William Holaday authorizing funding of four contractors programs for the remainder of Fiscal 1958.

Holaday's action released about $3 million in USAF Fiscal 1958 funds to continue both the Convair-Radio Corp. of America and the Lockheed-Raytheon Corp. projects under the Wizard program until July when Fiscal 1959 money will became available. This action reversed Holaday's directive of January 16 (AW Jan. 27, p. 18) in which he assigned sole development responsibility for anti-missile weapons systems to the Army for development of the Nike-Zeus program by Douglas Aircraft Co. and Bell Laboratories. RCA was directed by Holaday to proceed with development of advanced radar required for the anti-missile program. But no funds were provided for any part of the USAF Wizard program, including RCA, beyond March 31 under Holaday's previous order.

Abandonment of the Wizard development program by order of Defense Secretary Neil McElroy on Holaday's recommendation touched off a bitter USAF and congressional row (AW March 17, p. 19) over the advisability of concentrating on a single, relatively unsophisticated anti-missile weapon system while the entire problem was still in an early development stage.

Lt. Gen. Donald Putt, USAF deputy chief of staff for development, and Lt. Gen. C. S. Irvine, deputy chief of staff for materiel, strongly criticized the McElroy order canceling Wizard and assigning sole development responsibility in this field to the Army's Nike-Zeus program in testimony before congressional committees. They contended that the entire problem was in too early a development stage for any decision on a particular system and urged that two, and possibly three, lines of exploratory development be continued for at least another year or two before a final decision was made. They also criticized the Nike-Zeus system's capability because of its admitted inability to detect enemy decoy tactics with ballistic missiles.

Gen. Putt was severely reprimanded for his congressional testimony on Wizard by Defense Secretary McElroy and has since confirmed long standing plans to retire from USAF in June after completing 30 years service. On March 3, after the congressional row, USAF Secretary James Douglas sent a letter to McElroy requesting that the Wizard program be re-examined at Defense Department level with a view to providing funds to continue it beyond the March 31 deadline set by Holaday. The answer from Holaday to this request was dated March 20, just eleven days before the fund cutoff was scheduled to become effective.

USAF officials have testified before Congress that approximately $72 million was earmarked for the Wizard program in Fiscal 1959.

Congressional critics of the Wizard cancellation based their opposition on two points:

• Putting all the anti-missile development funds into a single program at such an early stage in the attack on the whole problem of defense against ballistic missiles.

• Defense Department using control over funds appropriated for individual military services to alter roles and missions. Defense Department has previously assigned USAF the mission of area defense and the Army point defense out to a range of approximately 50 mi. Anti-missile defense is essentially an area problem with detection requirements up to 3,000 mi. and interception requirements to ranges of 1,000 mi. and altitudes up to 500 mi.

Recruiting Is Brisk But Selective at IRE

New York—Engineer recruiting at the Institute of Radio Engineers convention here—expected by many recruiters to be a barometer of things to come—was brisk but far short of the frantic drives of past year.

Spot check of a few of the several dozen firms that reserved recruiting suites for the IRE show confirmed AVIATION WEEK's earlier findings (Mar. 24, p. 18) that recruiters generally are being very selective:

• **Number of engineers interviewed** this year was about the same as last year for companies that recruited both years.

• **Fewer on-the-spot offers** were made this year.

Most companies preferred to wait, invite the better prospects out to their plant for a two-way inspection.

• **Much less window shopping** than in previous years. Engineers who came in appeared to be seriously looking for employment.

• **Large salary increases** are not being used as major inducements by recruiters. Recruiters generally were prepared to offer 10% over the present salary, perhaps up to 20% in certain special cases.

• **Sizable percentage** of engineers seeking jobs come from smaller companies that have been hard hit by last year's defense cutbacks.

Space Technology

NACA to Spearhead U. S. Space Drive

By Robert Hotz

Washington—National Advisory Committee for Aeronautics will get the major role in developing a national space technology program under proposals submitted to Congress last week by President Eisenhower.

The President recommended creation of a new agency—the National Aeronautics and Space Agency—to do basic research and development for both military and civil applications of space technology and to organize and operate the civil phases of a space exploration program. Nucleus of the new agency would be the scientific staff and research facilities of the NACA. Draft legislation detailing the proposals was sent to Congress by the Budget Bureau. A Fiscal 1959 budget proposal to finance the new agency's initial operations was being prepared for Congress.

The President's space plan called for a reversal of the current roles of director and advisory committee in the NACA. The new agency would be headed by a director appointed by the President subject to Senate confirmation. Director of NACA is now named by the 17-man advisory committee whose members are appointed by the President. Under the new proposal, the 17-man advisory committee would still be appointed by the President with nine non-government civilian members and eight members from government agencies most concerned with aeronautics and space technology of which "at least one member should be appointed from the Department of Defense."

This committee would serve as a strictly advisory committee to the director rather than as the policy making group as it does now in NACA. James Harold Doolittle, retired USAF general now a vice president of the Shell Oil Co., is currently chairman of NACA and Dr. Hugh L. Dryden is director. Although no names were mentioned in the President's message to Congress, it is widely assumed that both Doolittle and Dr. Dryden will continue in similar roles in the new agency. Advisory committee membership will probably change in certain categories to reflect more realistically the new agency's role.

Among the principal points regarding the new agency in the President's message were:

• **National Aeronautics and Space** Agency "should be given that authority which it will need to administer successfully the new programs under conditions that cannot now be fully foreseen."

• **All resources of the NACA** "will immediately be transferred to the new agency" on enactment of legislation creating it.

• **Pay scales for scientific personnel** in the new agency will be exempt from current Civil Service regulations to permit hiring of the best available talent at rates competitive with industry.

• **Department of Defense and NACA** are now conducting a review of all space projects to determine which ones should be transferred to the jurisdiction of the new agency.

• **Preparation of an operating plan** for the new agency by Department of Defense and NACA to "assure support of the new agency by organizations, facilities and other resources of the Department of Defense either by cooperative arrangements or by transfer to the new agency."

• **Preparation by NACA** of detailed plans "as may be required to prepare for the assumption by the National Aeronautics and Space Agency of the responsibilities contemplated for it. Those plans are to set forth the specific new space programs to be initiated and are to describe the internal organization, management structure, staff facilities and funds which will be required." The President specified that NACA is to discuss these plans with the National Science Foundation and the National Academy of Sciences to "determine the scientific objectives of our space programs."

The President's proposals were the results of studies by his special scientific advisor, Dr. James Killian, president of the Massachusetts Institute of Technology, and the temporary staff assembled for the task.

Although all final plans for the new agency are contingent on the specific type of legislation endorsed by Congress, some of the broad areas in which the new agency will move are apparent. They include:

• **Creating an avionics** capability for research and development work that NACA does not now possess. Indications are this will be done by a contract with a civilian research organization rather than by building and staffing a new NACA facility.

• **Heavier contracting program** with industry, research foundations and universities. These contracts will fall into three categories: basic research and study grants, primarily with universities and foundations; development hardware contracts with industry, and laboratory research contracts such as the requirements for an avionics capability.

• **Expansion of** NACA's existing facilities to cope with the new role. For example, the missile test center at Wallops Island, Va., will undoubtedly be greatly increased in capability both for launching research vehicles and development of hardware for space exploration. NACA's Space Technology Committee created several months ago already has been studying the requirements for a launching base for exploratory space vehicles with a view toward determining the possibilities of the best location for a base of this type as close as possible to the equator. Plans for lunar and other types of space probes in the next 18 months will undoubtedly use existing facilities at Cape Canaveral, Fla., or at Camp Cooke, Calif. But a new launching site for space vehicles probably will be included in the new agency's program.

• **Continuance of the NACA's** basic research and development on manned flight vehicles, ranging from the subsonic to the hypersonic for the Air Force, Navy, Army and civil aviation.

NACA has been broadening its research base since early in 1952 to include a heavier role in space technology in such areas as the X-15 manned space research vehicle program; the reentry problem and aerodynamic heating; new propulsion systems including ionic propulsion; nuclear power systems and high energy fuels, and structures problems. However, under the new plan proposed by the President, NACA will have to expand its activities heavily on the development end of the spectrum and enter into the operational field for the first time with responsibilities in this area for exploratory vehicles in the civil phase of the space program.

The President's proposals for the National Aeronautics and Space Agency are expected to meet little opposition in Congress. Biggest congressional demand has been for a specific plan of action with a predominantly civilian tinge—a requirement which the NASA plan meets.

Opposition plans that gathered some momentum in the vacuum created by the absence of a specific White House proposal are expected to evaporate with the appearance of this legislation. Backers of the Atomic Energy Commission and a cabinet-level Department of Science to do this job are pretty well conceding to the NASA plan. Biggest opposition is likely to come from segments of the scientific community who hoped for a completely new agency that would offer more jobs and prestige plums to newcomers to the field.

One major unresolved question is the relation of NASA to the Advanced Projects Research Agency of the Defense Department. It is unlikely that this relationship will be clarified until the status of ARPA is clearly defined in the Defense Department reorganization proposals scheduled to be submitted to Congress by the President shortly. However, creation of the NASA is expected to eliminate much of the originally planned need for ARPA and strengthen the traditional direct relationship between NACA and the three services.

The President said that, pending enactment of legislation creating the new agency, he had approved an interim program for satellites and lunar probe launching under the direction of ARPA. He also said that, when the new agency was created, it would review these projects to determine which should come under its jurisdiction and which should continue under the Department of Defense. He indicated that the Defense Department would continue to be responsible for space activities peculiar to or associated with military weapon systems or military operations. However, NACA in the past has provided a broad research foundation for military aerial weapon systems development and will undoubtedly continue in this role in the future with perhaps heavier reliance on contract operations.

Ventral Fins Mark F8U-2

Main external changes on Chance Vought's F8U-2 Crusader are additions of two ventral fins and two airscoops mounted on the tailpipe near the vertical fin for afterburner cooling. Powerplant of the new version is the Pratt & Whitney J57-P-16 engine. First prototype (below) still carries the F8U-1 designation underneath slab tail. Note titanium section forming the tailpipe which was left unpainted. Flight shot shows second prototype.

President Requests Additional $1.6 Billion for Fiscal '59 Defense

By Katherine Johnsen

Washington—Additional defense funds of $1.6 billion for Fiscal 1959 approved by the President last week falls $300 million short of Defense Department requests. A total of $1.5 billion was submitted to Congress by the President. Another $136 million will be added to the military public works budget. Major projects to be financed with supplemental funds are:

• **Boeing B-52 Bomber-KC-135 tanker** program, $400 million to $450 million. This is for 39 B-52s—which will continue production through the 1960 calendar year, and 26 KC-135s. It will add one B-52 wing to replace a medium-range B-47 wing, increasing the number of B-52 wings from 11 to 12. USAF's vice chief of staff, Gen. Curtis E. LeMay has said that 14 wings is the minimum heavy bomber requirement. Financing for 602 B-52s and 400 KC-135s previously had been provided.

• **Anti-missile missile program,** $30 million. This is for Army's Nike Zeus and Plato programs.

• **Titan intercontinental** ballistic missile program, $50 million to $100 million. This is to accelerate development and provide for base construction—either one underground base or two above-ground bases. Gen. LeMay had asked $129 million additional to push work on the Titan booster alone.

• **Minuteman multi-purpose** ballistic missile program, approximately $100 million. This will accelerate development of USAF's solid propellant ballistic missile project.

• **Hound Dog,** approximately $100 million. This will provide for the first major production order to North American Aviation for the electronic countermeasures missile to be used by the B-52. Previous financing totals approximately $100 million.

• **Polaris fleet ballistic missile** program, $350 million to $400 million. This includes funds for two additional nuclear-powered Polaris submarines and the missiles to equip them. Three Polaris submarines previously have been provided for, making a total program of five. Navy had urged a program of nine.

• **Pacific Missile Test Range,** Pt. Mugu, Calif., $36 million. This will finance "minimum" instrumentation of the east-west tracking range across the Pacific, including instrumentation of some tracking aircraft.

• **Anti-submarine warfare,** $120 million to $125 million, including $4 million for ASW aircraft.

Sen. Henry Jackson (D.-Wash.), chairman of the Atomic Energy Military Applications Subcommittee, complained that "it is inconceivable that the administration would order less than one complete wing of B-52s, which with spares totals 52 planes, and the 35 KC-135 tankers it would require to support a full wing of B-52s at the ratio of two tankers for each three B-52s."

Jackson also protested that "equally disappointing is the half-hearted effort the administration is making with the Polaris system. . . . We should provide funds now for an immediate start on a minimum of 15 Polaris submarines and work as rapidly as possible toward a goal of 100." Other deficiencies, according to Gen LeMay are:

• **North American X-15.** Gen. LeMay has testified that $42.2 million more is needed promptly to adapt boosters to USAF's high-altitude research vehicle.

• **Chemical bomber program.** Gen. LeMay has urged an additional $42 million to expedite the program.

With the acceleration of numerous programs, Defense Department has raised its estimates of expenditures. Spending for Fiscal 1958 is now estimated at $39.5 billion, instead of $39 billion; and for Fiscal 1959, at $40.3 billion, instead of $39.8 billion.

The $1.45 billion request to Congress last week is divided: USAF, $577 million; Navy, $453 million; Army, $246 million; and Advanced Research Projects Agency, $180 million, to support anti-missile missile, satellite and other programs.

Supplemental Requests for Fiscal 1959

Washington—Following is a partial breakdown of the administration's requests for supplemental Fiscal 1959 funds:

(000 omitted)

	Original Estimate	Increase	New Estimate
OFFICE OF THE SECRETARY OF DEFENSE			
Advanced Research Projects	$340,000	$180,000	$520,000
Research and Development	471,000	27,700	498,700
Procurement of Equipment and Missiles	1,405,000	218,100	1,623,100
NAVY			
Aircraft and Related Procurement	2,069,105	23,490	2,092,595
Aircraft and Facilities	840,548	3,460	844,008
Research and Development	641,045	109,040	750,085
AIR FORCE			
Aircraft and Missile Procurement	5,888,800	518,400	6,407,200
Aircraft and Missile Support	2,146,000	49,700	2,195,700
Research and Development	719,000	9,000	728,000

Super Bomarc Could Triple Current Speed

New York—Speeds triple those reached by current production ramjet engines of the Boeing Bomarc are attainable for the Super Bomarc within today's state of the art, permitting it to attack targets well outside the earth's atmosphere, Roy E. Marquardt, president of the Marquardt Aircraft Co., told the New York Society of Security Analysts here last week.

Improved ramjets developed in the program for the 400-mi. range solid booster Super Bomarc have been test flown on Lockheed's X-7 ramjet test vehicle at Mach 3.95 and at altitudes higher than 100,000 ft. Maximum speed for the current Bomarc is Mach 2.5.

Marquardt's annual report, distributed at the meeting, depicted the evolution of Marquardt's engines for the Bomarc and future projects beginning with the RJ43-MA-1 tested in the X-7A-1. From this evolved the RJ43-MA-3 for the XIM-99A Bomarc, the RJ43-MA-5 originally intended for Lockheed's Q-5 drone and the RJ43-MA-7 for test in the X-7A-3 and use in the XIM-99B Super Bomarc.

Also shown as developments are the RJ57 engine with no test vehicle or application specified and the RJ59 engine for test in the X-7A-2 and a project indicated but not named.

All these engines were listed under a general heading of supersonic. An undesignated hypersonic engine was listed as in existence since 1955. The chart indicated both the Super Bomarc and the nuclear ramjet engine would be in existence before 1960.

Marquardt, which is just completing a research facility at Van Nuys, Calif., for testing small engines and components at speeds up to Mach 12, also visualizes use of ramjets in space.

Ramjets might be used to boost rockets to high altitudes for launching for establishment of space stations, at a great saving in takeoff weight. Marquardt said, adding: "such stations, in turn, I believe, will eventually be used as launching platforms for true interplanetary vehicles—powered I am sure, by other Marquardt engines we are already studying."

The company, with its own funds, also has been studying the recombination ramjet (see p. 65).

Ramjets have capability for very high altitudes if speeds are high enough, Marquardt believes. At 6,000 mph., he said, compression ratio of a ramjet is on the order of 1,000 to 1. Thus a ramjet could operate at these speeds as efficiently as at sea level in an atmosphere one thousandth as dense as sea level.

Marquardt has contracts for or is interested in several nearer-term projects, including:

• **Nuclear ramjet.** Marquardt's new Astro Division is associated with the University of California Radiation Laboratory and North American's Atomics International in Project Pluto to develop this engine. Marquardt said that this project now is a relatively small company effort.

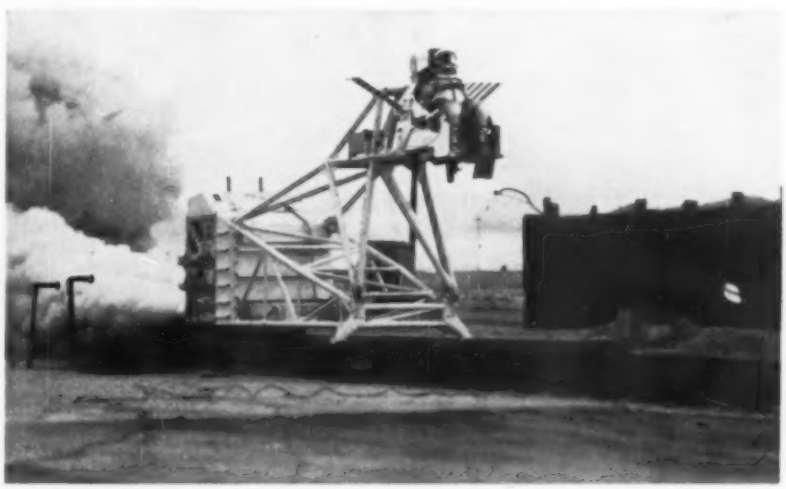
• **Manned ramjet bomber.** Marquardt said current thinking on this vehicle is in the Mach 4-6 speed range. Such a project (AW March 31, p. 18) could eventually lead to commercial ramjet transports, Marquardt said. In this connection he disclosed his interest in the French Leduc type of piggy back launching system as an efficient and economical method for bringing ramjets to operating speeds. Marquardt said Leduc's setbacks on obtaining support from the French government had prevented progress on an agreement.

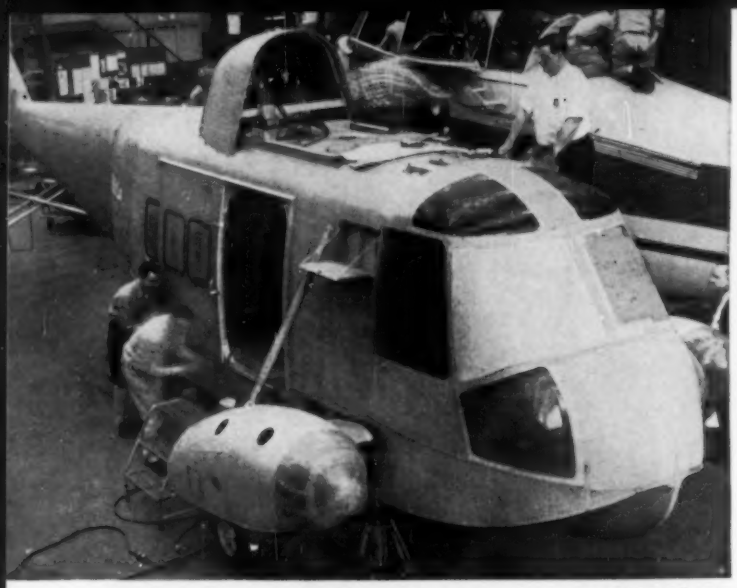
• **High energy fuels.** Boron fuels look particularly attractive in ramjets, Marquardt said, because the problem of deposits on moving engine parts met in turbojets is absent. Olin Mathieson Chemical Corp., associated with Marquardt in the Omar combination, reports its boron fuel program is in its infancy, but expects significant developments by the end of the year.

Sales of $39,865,000 and earnings of $1.62 a share on profits of $903,000 for 1957 were reported by Marquardt. Progressive improvements in earnings through 1961 were forecast as the company switches over to fixed price contracts this year; these sales will not appear in company earnings until next year, however. Cost-plus contracts now make up 95% of the company's sales.

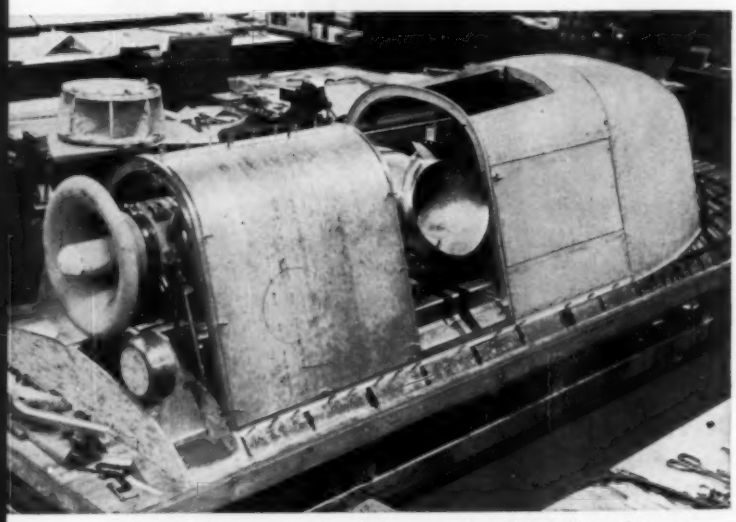
X-15 Space Suit, Seat Tested

Effect of high speed wind blast on X-15 research plane ejection seat and pilot pressure suit is under evaluation at USAF Flight Test Center experimental sled track at Edwards AFB, Calif. Dummy clad in suit is prepared for run (top photo). Seat vanes are stabilizers designed to keep seat from tumbling after ejection. Seat also features shock wave plate (between dummy's feet) which interrupts wave, reducing pressure on pilot by one-third. Sled, powered by solid propellant rockets, starts run (below).

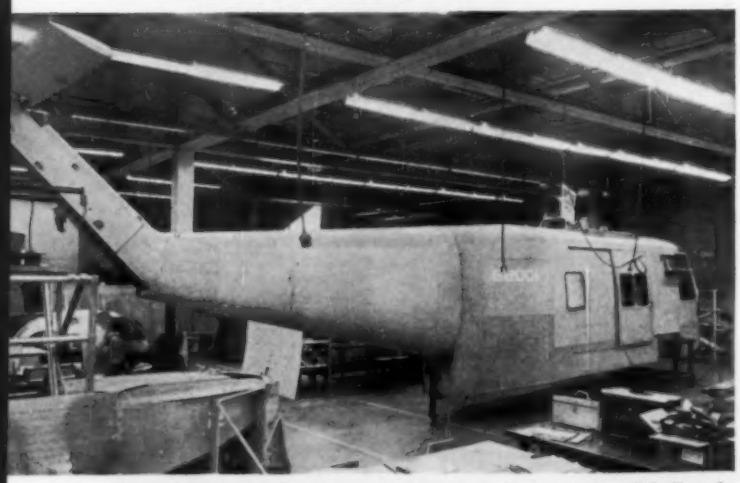




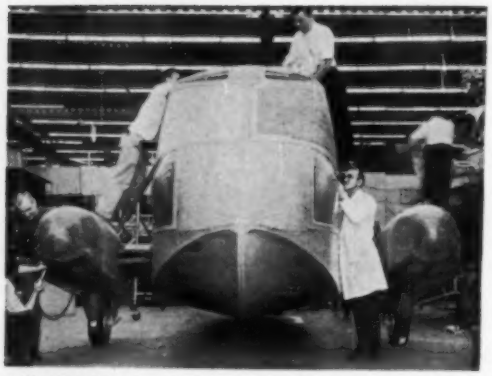
HULL section awaits installation of engine and rotor head in Sikorsky experimental shop. Helicopter in background is S-55.



T58 TURBINE engine has fairing skin installed before placement on S-62 fuselage. Opening at top right is for rotor head.



TAIL stabilizer has been moved to upper section; note second hull under construction at left. Tail fairings have not been installed.



HELICOPTER boat hull has passed waterproofing tests. Design is said to give improved water characteristics.

S-62 Nears Completion; Second Hull Under Way

Production of S-62 helicopter with flying boat hull, is proceeding rapidly at Sikorsky Aircraft Division of United Aircraft Corp., and the May schedule for first flight is expected to be met easily. Aircraft is powered by General Electric T58 gas turbine engine and uses parts from Sikorsky S-55 (AW Dec. 30, p. 25). Seagoing hull utilizes Fiberglas fairings at rear and bottom of tail section and on forward section of both sponsons. Engineers are considering construction of entire Fiberglas hull for future model. Electrical equipment and flight control linkage is located in special compartments on main cabin's forward bulkhead, for easy access and maintenance. Major production change from original drawings was repositioning tail stabilizer to top of section, from previous position on tail section near fuselage top. Aircraft, designed for commercial use, will have full power available up to 17,000 ft.

DOORWAY connects crew, passenger compartments.

Moon Shot Vehicles Near Assembly

Washington—First test vehicles for the Air Force Ballistic Missile Division moon shot program authorized by the Advanced Research Projects Agency are nearing the assembly stage.

Early firings are planned for the Douglas Thor first stage and for the second stage which uses an Aerojet-General second-stage engine from the Vanguard. The moon probe vehicle's third stage which still must be developed will be used later when the complete rocket is tested.

The moon probe brings to a minimum of eight the number of major projects in progress or just beginning at BMD. These are Atlas, Titan, Thor, WS-117L Pied Piper, Minuteman, an out-of-the-atmosphere explosion of Thor nuclear warhead for Operation Hardtack, moon probes and the propulsion part of the man-in-space project designed to return a man from orbit in 1959 (see page 26).

Exact management implications of the Administration's moon shot programs, ARPA's first move to bypass the Pentagon and cut red tape, were not completely clear last week.

ARPA used its authority to deal directly with Air Force and Army development agencies and assigned them the task of implementing the moon probes (AW March 31, p. 17). The move circumvented the service secretaries, military staffs and research and development commands to achieve what ARPA officials term "close management."

Only the initial step of this close management has been announced. USAF's Ballistic Missile Division and the Army Ballistic Missile Agency will submit their moon probe proposals to ARPA as directed. ARPA will then revise and modify them as considered necessary. Otherwise, the degree of freedom to be granted the commanders of BMD and ABMA is uncertain.

While this method of administering a development program sets a precedent in the Pentagon, it is not the only method ARPA is considering or has the authority to employ. A spokesman listed three methods ARPA could use:

- **Award a contract directly** to a private firm and then assign the administration of the contract to one of the services.
- **Authorize a development command** of one of the services to proceed with a specified project as was done with the moon probe projects.
- **Assign work through the service** secretaries, as was done with the anti-missile missile program, ARPA's other responsibility to date.

In the direct line of command from ARPA to the service development agencies on the moon probe project, carbon copies of communications were sent to the service secretaries. To make certain that ARPA development work does not interfere with ballistic missile projects already in progress at BMD and ABMA, coordination is maintained with William Holaday, Defense Department director of guided missiles.

Actual tasks that have been assigned are three moon probes for BMD; one and possibly two probes for the Army. The Army also will launch two or three additional earth satellites.

The probes are intended to explore space near the moon and send back information on the moon's surface gathered by a "mechanical ground scanning device" that will be developed by the Naval Ordnance Test Station, at Inyokern, Calif. Under present plans, the picture the scanning device will return to earth will be cruder than a regular TV picture. Simplicity of equipment is dictated by size of probe vehicle.

F-100D With Pilot Makes Zero-Launch

Los Angeles—Using a solid propellant rocket booster, a North American Aviation F-100D recently made a successful zero-launch at Edwards AFB. Launch was of a piloted aircraft, with North American engineering test pilot A. W. Blackburn at the controls.

Launch was effected with the airplane having its gear, flaps and wheels extended, as well as the leading edge slats. No external stores were carried. Gross weight at launch was about 33,000 lb.

Angle at launch was 20 deg., a critical parameter. Early experience in launching "iron cross" dummies which closely approximated the F-100D in size, area, mass distribution and center of gravity showed that launch at one degree too steep an angle resulted in dummy performing a loop.

The aircraft takes off with full engine power and afterburner, operating together with a booster bottle to supply a thrust vector which not only achieves sufficient speed but also altitude at steady rate.

Spectators at the Edwards launching included a group of NATO officers. A significant use of zero launches would be in European areas where a number of tactical air units are deployed.

Adding to the tactical significance of the zero launch system, is the fact that F-100D aircraft already in field operational service with Air Force units are stressed for this maneuver, need no basic structural modification to assume zero launch capabilities.

While the F-100D is the only current Century-series airplane that has undergone a zero-length-launch program, there is a possibility that aircraft such as Lockheed's F-104A may undergo similar development.

F-104A is considerably lighter than the F-100D, would require no major structural redesign to assume zero length launch capabilities.

Army Drone Constructed of Plastic

Zero-length-launched, recoverable Army SD-2 all-weather surveillance drone's wing, fuselage and tail components are of laminated plastic construction for ease of replacement, repair. Drone was designed and developed by Rheem Manufacturing Co., Downey, Calif.

General Dynamics Sales at $1,500,000,000

New York—General Dynamics Corp. net sales in 1957 reached a record high and passed the billion dollar mark for the second consecutive year.

Net sales totaled $1,562,538,900 compared with $1,082,861,349 in 1956. Net earnings, also a record, were $44,278,763 compared with $35,687,692 in 1956 or $4.80 a share compared with $4.01 a year earlier.

The corporation includes the Convair and Canadair divisions as well as non-aviation segments. Other financial reports:

• **Fairchild Engine and Airplane Corp.** Earnings declined sharply in 1957 largely because of the charging off of $8,710,537 of current earnings to expenses of the F-27 turboprop transport program. Earnings were $503,331 on sales of $158,621,612 or 17 cents a share, compared with earnings of $1,951,484 on sales of $155,076,754, equal to 64 cents a share for 1956.

Had it not been for the F-27 investment, profits would have ranked with the best years in the company's history, the report said. This same program will produce a sizable loss for the first part of 1958, the report said, but the rest of the year should show a profit. The first F-27 is scheduled to fly this month.

• **Lear, Inc.** Sales of $64,692,576 in 1957 topped the 1956 total of $63,900,000, a previous record for the company. Net income declined because of government stretchouts and cutbacks from $1,506,018 or 65 cents a share in 1956 to $858,921 or 36 cents a share.

• **Curtiss-Wright Corp.** Diversification into commercial fields helped hold sales and earnings at high levels. Sales in 1957 totaled $598,621,622, with earnings of $40,075,582. The 1956 totals were $571,064,793 for sales and $43,153,518 for earnings.

• **Ryan Aeronautical Co.** First quarter 1958 earnings showed a 72% increase over the same period last year—$510,146 compared with $296,656. Sales for the same period totaled $13,033,949 compared with $12,220,314 for the period a year ago, indicating an improvement in the ratio of profit to sales.

Army Developing Long-Range Drones

Washington—Army is developing both short and long-range reconnaissance drones equipped with radar, infrared, television and/or cameras for combat surveillance, Lt. Gen. Arthur G. Trudeau, new chief of Army research and development told the Armed Forces Communications and Electronics Assn. last week.

Lycoming Engine Built For Business Planes

Latest powerplant in the Lycoming engine line is six-cylinder direct drive engine developing 250 hp. Intended for business aircraft application, the first aircraft to be powered by the new engine will be an improved version of the Piper Comanche.

Engine, designated Model O-540-A1A weighs 396 lb., giving it a hp./lb. ratio of .63 to 1. Fuel is minimum 91/96 octane.

Standard engine accessories include 12-volt Delco-Remy starter, generator, voltage regulator, Marvel-Schebler MA45 carburetor and Bendix S6LN20 (right) and S6LN21 (left) magnetos. Propeller governor drive, duel pump drive, vacuum pump drive, and hydraulic pump drives are offered as optional equipment as well as 12-volt 35 and 50 ampere generators, and 24-volt starter and generator. Engine has CAA certificate No. 295.

Gen. Trudeau, a civil engineer and graduate of West Point, takes over the post formerly held by Lt. Gen. James Gavin, whose resignation became effective last week.

Army will need 11 navigation aids and other methods for controlling the "thousands of Army aircraft which we will use," Gen. Trudeau told the AFCEA. In the field of reconnaissance, Gen. Trudeau said the Army "cannot properly employ weapons with ranges of hundreds of miles without a commensurate increase in our target acquisition capability . . . one of the greatest challenges we face today."

The new chief of research and development also called for increased use of computers and automatic data processing in logistics and administration, in air defense and counter-missile systems. Army also needs better training simulators for its aircraft and missiles, he added.

Atlantic City Chosen As AMB Test Center

Washington—Atlantic City, N. J., Naval Air Station has been selected by the Airways Modernization Board as site for its new National Aviation Facilities Experimental Center that will be used to evaluate new traffic control systems and techniques.

Occupancy and operation of the new center could begin as early as July of this year if negotiations are speedily concluded with Atlantic City officials for use of the required land, according to AMB Chairman Elwood Quesada.

Selection of Atlantic City from the nearly 1,800 possible sites considered was based on a number of factors, including:

• **Both free airspace** to the east and relatively dense civil-military traffic to the west will enable facility to conduct experimentation tests over the ocean, yet evaluate systems and techniques later under operational conditions.

• **Established facilities** and plant, which will be vacated by Navy, minimize the new investment required and will enable AMB to put new facility into operation quickly.

• **Variety of weather conditions,** including a number of overcast days, provides the type of environment needed for AMB tests.

• **Proximity to first SAGE** air defense system installation will simplify integration of new traffic control system developments with SAGE system.

• **Availability of carrier-based** aircraft operations for participation in AMB system tests.

Atlantic City site will continue to be used for commercial airline operations, Quesada says. Facility is expected to employ approximately 225 technical and professional AMB personnel during Fiscal 1959 and will have a $12 million budget for its first year's operations.

News Digest

Vertol Aircraft Corp. rolled out its Model 107 tandem rotor helicopter developed with company funds and began ground tests at Philadelphia International Airport. Helicopter, powered by two Lycoming T53 turbine engines, will fly this month (AW Feb. 17, p. 23).

Argentine Airlines is buying Comet IVs to replace DC-7s on its routes between Argentina, London and New York. Manufacturer de Havilland last week had not confirmed final settlement of the contract, but it is understood at least six of the four-engined jets are involved in a $20 million order. Delivery is expected this year.

Republic Aviation Corp. employes last week called a strike for midnight Wednesday but returned to work next morning without setting up picket lines at Farmingdale, N. Y., on orders of International Assn. of Machinists negotiators. Union and management last week were huddled in last ditch sessions in attempt to avert the walkout. Major issue is wages. Union wants increases from 26 to 28 cents an hour; company offer is 10 to 12 cents. Union said 3,000 members voted to strike, 900 dissented.

Chrysler Corp. has received a $25,767,293 Army contract for Jupiter spare parts and components for training.

EEMCO ANNOUNCES

...a new electro-mechanical actuator to drive airborne cargo bin conveyor systems

EEMCO electro-mechanical rotary actuator Type D-961 has been developed for use on airplanes to drive their baggage bin conveyor systems. Operated either electrically or manually, the actuator moves the bins forward or aft, and holds the bins in any desired place.

This new **EEMCO** rotary actuator consists of an intermittent duty 200 volt, 3-phase, 400 cycle AC motor and gear box. It is electrically reversible and includes an AC operated brake, thermal overload protection, manual drive input shaft, and reverse torque lock mechanisms.

The unit is designed for normal operating load of 810 in. lbs. torque at 16 rpm, 1.4 amps, and meets all pertinent military specifications. The maximum static load without permanent deformation is 5100 in. lbs.

EEMCO specializes in the design and production of precision-built actuators and motors. The majority of the latest and fastest aircraft and missiles carry one or more **EEMCO** systems. Prime contractors of civil and military aircraft rely on **EEMCO**'s years of experience in the exclusive design and production of motors, linear and rotary actuators.

SPECIFICATIONS FOR TYPE D-961

Motor:
200-volt, 3-phase, 400-cycle AC motor with gear box.

Normal operating load:
810 in. lbs. torque at 16 rpm, 1.4 amps.

Maximum static load:
5100 in. lbs.

Weight:
12 pounds.

Qualification:
Type D-961 has been designed and qualified to meet applicable military and aircraft manufacturers' specifications.

Your inquiry is invited.

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ABC ABP

Financial Crisis Hits All-Cargo Airlines

Business recession, regulatory policies blamed; CAB gets first all-cargo airline subsidy request.

By Glenn Garrison

New York—Critical point in the touch-and-go financial history of domestic all-cargo airlines appears to have been reached after nine years of the air freight experiment.

Within the past two months, two of the four domestic all-cargo certificate holders have formally told Civil Aeronautics Board they cannot carry on under present conditions. The first request for all-cargo airline subsidy has been presented to CAB and at least one more is almost sure to follow.

Business recession, harder-to-get military contract work, CAB regulatory policies, and competition from combination carriers are high on the list of reasons given by the all-cargo lines for their present predicament.

Slick Airways in February applied for a one-year suspension of service to all points served on its certificate, and indications are that the airline will go out of business unless conditions change. It plans to ask for subsidy within the next few weeks. Riddle Airlines last month asked for subsidy mail pay to enable it to survive the economic recession.

Flying Tiger Line, though still making money on its overall operations, is seriously considering asking for subsidy to bolster its common carriage business. The fourth all-cargo domestic airline, AAXICO, is relatively new in the certificated business and has been proceeding with caution in this phase.

Ever since Slick and Flying Tiger got the first all-cargo certificates in 1949 on a temporary, experimental basis, common carriage business of the all-cargo lines has never paid its own way. All the cargo airlines, banking on the future of air freight, have in effect subsidized this business with other activities. But though volumes have grown tremendously, results are disappointing.

Here is the critical situation as seen by each of these all-cargo lines:

Flying Tiger, lustiest of the three still flying common carriage freight, hasn't "got its back to the wall," according to President Robert Prescott. But if the business decline continues and other sources of revenue slacken off, "we'll be in trouble," he said. Regarding other sources, the bidding for Military Air Transport Service business is becoming stiffer as more aircraft are available from various types of airlines. Prescott said if carriers could "pry MATS loose" from 20% of its cargo traffic the problem would be solved. Some restrictions should be set on the manner of contracting military work, however, as some operators make money-losing low bids to keep equipment operative, he added.

Flying Tiger will determine within a week or so whether or not to ask for subsidy. If the airline does, it can expect American Airlines and other combination carriers to "come down on us with all their wrath," Prescott said. But Flying Tiger would expose itself to attack rather than let its common carriage business go down the drain. This solid and substantial area is where the airline wants to build its future, and contract business is not interesting for the long run. While January and February scheduled volume was best in the company's history, increasing costs plus the need for new equipment have made the freight operation increasingly critical.

Cargo operations of the domestic trunklines have helped develop the air freight business, but they have an advantage over the all-cargo lines, Flying Tiger believes. On many of their routes, there is no competition and they can make about 22 cents a ton-mile against about 18 cents for the airfreighter, according to Flying Tiger. Alternatives for Flying Tiger now are: keep plugging and try to get over the hump by present means; turn to the government for help; or "find some magic way to get the right airplane."

This airplane exists today—Prescott favors the Douglas DC-7D turboprop proposal—but money must be found to buy it. New equipment like this is absolutely necessary for survival in the competitive airfreight business, he says.

Flying Tiger last year made a $392,246 net profit before taxes on all its operations. Common carrier business grossed $9,450,018 and showed a net operating loss of $1,614,730. Revenues from other operations such as military contracts and North Atlantic passenger charters totaled $22,570,024, with a profit of $2,006,976.

Slick plans to apply for subsidy within the next few weeks, and observers believe the outcome of this request may determine whether the airline resumes services or not. Meanwhile, the carrier is making various moves which would enable it to get out of business fast if necessary. It has eight DC-4s which it wants to sell, and plans to sell five DC-6s coming off the line this year. These planes may be sold before delivery to Slick, probably to foreign airlines.

Five DC-6s now are flying MATS contracts, but volume of business doesn't appear heavy enough to keep them all busy. One of the DC-6s is going to Alaska Airlines on long-term lease this month, and the others are up for lease or sale. Other parts and equipment are up for sale, and Slick's headquarters building in Dallas is up for sale or lease. Despite all these moves, the airline says there is still a chance that airplanes will be bought or leased to resume service next year. Decision will be made at the end of this year and will depend on general business conditions and what action CAB takes on subsidy and other issues.

Slick's immediate financial crisis leading to suspension was caused by slumps in MATS and engine overhaul business. In January and February of 1957, the airline grossed $1,195,000 from MATS work and $506,000 from engine overhaul. In the same months of this year, it grossed $516,000 from MATS and $102,000 from overhaul.

Falloff of this business was attributed to general cutbacks in military spending last year. What MATS work was available was hurt by a bid war which resulted in some below-cost contracts, as Prescott pointed out.

Slick told the Board that it had "exercised little of its promotional responsibility in connection with the development of all-freight carriers as such. . . . The original certificate proceeding consumed over three years of procedural maneuvering and, when issued, the certificate was limited in scope, it did not include air express. . . . The renewal proceeding required a second lengthy hearing and resulted in another temporary certificate."

The airline says one problem has been that the tariff structure has never been allowed to follow the curve of rising costs. Despite increases in 1949, 1953 and 1956, CAB-set rate minimums haven't provided tariffs high enough to cover rising costs. Another factor is CAB restriction against carrying traffic between points within general regions served.

Despite an intensive cost reduction program last year, Slick says, drying up of outside business left no money to support the common carriage operation. And, with the business recession,

the common carriage volume also was down—fall auto industry freight and pre-Christmas soft goods business, for example.

Slick reported a loss of $3,114,000 in common carrier operations for the year ended June 30, 1957, compared with a total system loss for the same period of $2,021,000. From the 1957 date to Feb. 1, 1958, Slick lost more than $1,200,000 for all operations, it told CAB.

Riddle does not believe, it told CAB, that the Civil Aeronautics Act intends that "the Board stand by in witness of the quiet expiration of the all-cargo industry, carrier by carrier. . . ." The airline said subsidy to ride out the present storm was a matter of survival (AW Mar. 31, p. 32).

But while seeking aid, Riddle plans to help itself and is not turning over its problems to the Board "in a gesture of helpless desperation." Recent measures of self-help, Riddle's application said, include election of new President George L. Giles (in February, with former President John Paul Riddle becoming chairman of the board); cost-cutting moves including 16.1% reduction in employes and temporary suspension of service to five cities; modification of C-46 aircraft to improve efficiency; development of new revenue sources and traffic.

Giles told AVIATION WEEK that the program under his management included a general tightening up of the common carriage operation and the elimination of "fringe" activities such as the airline's T-category C-46 conversion work for other carriers. He said performance of such work by Riddle had tended to distract from the airline's efficiency in maintaining its own equipment and schedules. Royalties from C-46R conversions done by other firms, however, are a continuing revenue source. Riddle's own fleet conversion now is being handled by American Airmotive, Giles said.

Riddle has a problem in its relatively short-haul situation. One reason services were curtailed, Giles said, was to increase average stage length.

Logair contracts have been a Riddle mainstay, but new setup for these airlift operations is expected when contracts expire in June and hence the business is uncertain. As of last month Riddle had 15 C-46s engaged in the Logair work, against 13 of the planes in common carriage.

AAXICO received its certificate in 1956 and began operation late that year to only three of its authorized 15 cities on a north-south pattern. It has not expanded the route, operates three of its 40 C-46s in common carriage to the three cities. Seventeen of the planes are in Logair work. The other C-46s are leased or chartered. Next month AAXICO will get a DC-6C, which it will lease out for a time to reduce depreciation and will wait for a suitable spot for it on the airline's routes.

AAXICO's approach has differed from that of the other carriers. It has moved very slowly, gradually building freight business, which it says is still losing money but improving. Being relatively less committed to its common carriage route, the airline has less of a problem in subsidizing it.

As Prescott outlined previously, it seems likely that the trunk carriers will come down "with all their wrath" on subsidy applications from the all-cargo lines. American Airlines, in fact, planned to file last week an objection to any such grant. American's position: Riddle in applying for rights to carry air mail specifically put its request on a service, or non-subsidy, basis; CAB specifically limited the air mail privilege to service rates on the basis that public convenience and necessity would permit no other; neither Riddle nor other cargo lines challenged the Board's authority to grant this type of mail authority; the Board's interpretation of its statutory power to so limit the rights was a proper one.

Riddle and the other carriers have indeed in the past strongly disclaimed any intention of asking for subsidy. Riddle and AAXICO got their first air mail rights in 1956; express rights had come the previous year. Flying Tiger and Slick got their first air mail as well as express authority in 1956.

Combination carriers have resisted any encouragement of the all-cargo lines' development through intervention in various proceedings involving the cargo carriers' routes. In the Air Freight Renewal Case, decided in 1956, American's position was that the record of the all-cargo lines showed no public need for their services for the transportation of freight. American also maintained that the public did not need the cargo lines' services to carry mail.

The Board, however, found in part that ". . . These (all-cargo) carriers are performing a useful public service and . . . their service is required to exploit our vast untapped cargo potential in the interest of our commercial needs . . . . We would be derelict in our duty if we did not give them as much aid and encouragement for economic survival as we can within the framework of the act."

How fast an aviation picture can change is illustrated by testimony last April before Senate subcommittee hearings on a bill to give the all-cargo lines permanent certification. At that time, Joseph H. Fitzgerald, director, CAB Bureau of Air Operations, told the Senators in part:

"As a matter of fact, it looks as though in the past 18 months this (all-cargo) industry has finally started to achieve the solidity that we had hoped for. I do not want to leave the impression that the Board regards these carriers as shaky at all. . . ."

TWA Flight Engineers

New York—Trans World Airlines last week became third major U. S. air carrier to assign mechanic-qualified flight engineers as third crew members in jet transports. Company decision, latest development in dispute between pilots and engineers, was revealed by Warren Lee Pierson, board chairman, in a telegram to employes. It said that company policy will be to use "mechanic-engineer qualified individuals to perform the flight engineering function on TWA jet aircraft when the federal regulations require a separate crew member to perform this function and do not require such individuals to possess pilot qualifications."

Airlines previously assigning Flight Engineers International Assn. members to third crew man spots were Pan American World Airways and American Airlines.

East Germany Spurs Jet Transport Plans

Moscow—East Germany has designated 1958 as the starting point for an ambitious jet transport development program that includes wide-scale improvements of the East Berlin airport.

The Soviet satellite country has been told by Moscow to go ahead with a plan that will make Berlin's Schonefeld Airport a first-class intercontinental field able to accommodate aircraft weighing up to 352,000 lb. First stage of the project will begin this year with construction of an 11,800 ft. main runway.

East Germany's state-owned airline, Deutsche Lufthansa, is also looking forward to the completion by May 1 of the new Baade/Bonin Type 152 medium-range four-engine jet transport.

Arthur Pieck, Deutsche Lufthansa's director-general, reports that East Germany's airline traffic is steadily increasing. Domestically, the carrier's most important step last year was the opening of routes between Berlin, Barth, Dresden, Erfurt and Leipzig. According to Pieck, the airline's goal is to provide air service to "every large city and industrial district in the nation."

Deutsche Lufthansa is making extensive use of twin-engine, four-place Czech Aero-45s and single-engine Russian An-2s modified in East Germany for summer excursion flights. Russian-designed 26-seat Il-14 transports are being built at a Dresden factory.

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Miami Expands to Meet Traffic Increase

By L. L. Doty

Washington—Miami International Airport last week accelerated its terminal expansion program to prepare for a traffic increase this year that is expected to boost the airport into the nation's top-ranking business field.

As a result of the recent Civil Aeronautics Board decision in the Great Lakes-Southeast Service Case (AW March 31, p. 30), three major trunklines will make their appearance on the Florida scene for the first time. The Board last week announced the details of the four new routes it granted in the case.

The new route awards will bring the number of U.S. domestic carriers serving Miami from four to seven and increase the total of all airlines operating schedules into the airport to 27.

During Fiscal 1957, Miami International Airport handled 336,000 aircraft movements to rank second to Chicago's Midway Airport which had 372,000 aircraft movements.

Los Angeles was in third position with a total of 290,000 aircraft movements during the year.

The new service will increase the number of airplane seats available to and from Miami by as much as 45,000 per month. Each of the four carriers involved—Capital, Delta, Northwest and Trans World—are convinced that sufficient traffic is available to fill those seats at a reasonably high load factor.

Airline Plans

However, Capital, which was granted the right to fly between Buffalo-Cleveland-Pittsburgh and Florida, was restricted from operating any single-plane service from cities on its system west of Cleveland. In its exhibits in the case, Capital pointed out that only 58% of its traffic potential would be drawn from cities it served east of Cleveland. The airline feels that the restriction denies Michigan cities other than Detroit direct through-plane service to Florida.

Trans World Airlines, which was granted a route from St. Louis to Florida, is expected to open the new route with six flights a day to Miami using Lockheed Constellations and Martin 404s.

Emphasis will be placed on coach service in the schedules.

Northwest will operate DC-7C flights for first-class service and DC-6Bs for coach service with the new flights scheduled to begin about the middle of September.

Delta probably will operate its new route between Detroit and Miami on a service pattern similar to that covering its Chicago-Miami route.

Capital apparently is protected equipment-wise as the result of a provision in its agreement with General Dynamics Corp. covering the purchase of nine Convair 880 jet transports (AW Feb. 3, p. 40).

The agreement states that General Dynamics will lease for Capital from a third party "up to 10" new competitive piston-engine aircraft at any time after July 1. Since the provision was contingent upon the outcome of the Florida case, Capital presumably will use the leased aircraft to serve its Buffalo-Miami route.

Competition for Eastern

With the exception of the segment between Buffalo and Pittsburgh on Capital's routes, all the new services will provide additional direct competition to Eastern Airlines. Of the three new carriers entering the Florida market, only Capital carries some sales identity in Florida as the result of its seven-year-old interchange agreement with National Airlines.

Northeast Airlines, which won a New York-Florida route in late 1956, has run into difficulty in attempting to capture a large share of the market. In explaining its 1957 $4.3 million net loss, the carrier admitted that "as the newest of the three carriers in the East Coast-Florida market, we were at the greatest disadvantage."

Both Eastern and National are strongly entrenched in the Florida area and the new route awards promise bitter competitive battles for traffic, particularly if the Florida market dwindles next year as it did this season.

Miami Well Equipped

The Miami airport is well equipped to handle the additional traffic load from an air traffic control standpoint. Arrangement of four runways permit dual landings and takeoffs under normal conditions. Instrument approaches handled by the Miami air route traffic control center totaled 4,163 during Fiscal 1957 as compared with 74,000 in the New York area, 59,000 at Los Angeles and 51,000 at Chicago's air route traffic control center.

As a result, weather conditions do not normally bog traffic to a standstill as is the case at northern airports. Early morning ground-fog causes some delays in February and March, however.

Terminal facilities are not presently adequate to accommodate the new carriers and, last week, representatives of Northwest and Capital were in Miami to discuss temporary measures to handle ticket counter and office space and gate facilities.

A new terminal now under construction will be available for occupancy by December so that all airlines serving Miami will have sufficient ticket counter and waiting room areas.

As a result of the recent route awards, the addition of a sixth terminal loading finger will be required to provide adequate gate space.

Under original plans, four fingers were programmed. A fifth was added when Northeast began service last year; a sixth is now found necessary to handle the needs of Capital, Northwest and TWA.

The cost of the additional construction work is covered by the bond issue originally floated for the new terminal.

Route Details

Here are the details of the new routes designated by the Civil Aeronautics Board:

- **Northwest Airlines.** Chicago to Miami via Atlanta and Tampa-St. Petersburg-Clearwater with nonstop privileges between any of the southeast cities and Chicago. Northwest may provide single-plane service between these points via Chicago and any cities west on Northwest's system.
- **Delta Air Lines.** Delta's route between Florida and Cincinnati was extended northward to be competitive with Eastern's present Florida-Detroit service.

Orlando, Tampa-St. Petersburg-Clearwater and West Palm Beach were added to the route in addition to Miami and Jacksonville which the carrier now serves.

- **Trans World Airlines.** TWA was permitted to serve Nashville, Atlanta and Tampa between the terminal cities of St. Louis and Miami. Single-plane service is permitted from Florida to points west of St. Louis.
- **Capital Airlines.** Capital's new route permits service from Miami to Buffalo via West Palm Beach, Tampa, Jacksonville, Pittsburgh, Youngstown, Akron, Cleveland and Erie. Capital is restricted from providing any single plane service west of Cleveland. It cannot provide "local service" between Buffalo and Cleveland.

The airline is prohibited from providing single-plane service between cities south of Atlanta and cities north of Atlanta on its route to Washington. On flights between Buffalo and Youngstown and between Youngstown and Erie, passengers may originate and terminate at these points, but the flights themselves must originate or terminate at least as far south as Atlanta.

Fairchild F-27 Transports on Production Line

Five F-27 Friendship twin turbine-powered transports are in various stages of construction in this photo taken at Fairchild Engine & Aircraft Corp. plant at Hagerstown, Md. Company said first production model will fly soon and said engineering for cargo version is well advanced. Friendship will get more powerful version of Rolls-Royce Dart 511 engine by early 1959.

Pan American Jetliner Seminar Details 707 Flight, Crew Plans

New York—Pan American World Airways is making further progress with plans for operation of this country's first jet airliners probably sometime this fall.

Various phases of jet operations, expected to begin on the Atlantic run with initial Boeing 707-121s, were discussed in detail last week by the airline during a Pan American jet seminar. Ground handling plans were previously reported (AW Dec. 30, p. 28).

Among the main points:

• **Pan American** estimates $25,000-$30,000 each as the initial cost of combination suppressor-reversers which will go on the 707s. The units will cost more than $86,000 per airplane per year to use, exclusive of maintenance, according to John G. Borger, chief projects engineer. They will weigh about 200 lb. per engine. Suppressor-reversers for PanAm's 707s and its Douglas DC-8s will cut takeoff thrust 1-2½% by manufacturers' estimates. Cruise mileage per pound of fuel will be cut 2-4%, or as much as 5,000 lb. Boeing reverser is an internal cascade device with louvers in engine nacelles; Douglas plans an external clamshell type of device. Pan American expects a noise reduction of approximately six decibels or more with suppressors.

• **Spare engines** will be carried externally on PanAm's Boeing 707-321s and DC-8s on regular scheduled flights when emergencies arise at down-line points. Spares will be fitted to attachment points inboard of No. 2 engine with nose cones and tail plugs installed. Increase in drag from the 5,000-lb. engine will run about 2½%.

• **Jet crews** will be checked out on a straight seniority basis. Acceptance of jet jobs has so far been unanimous on this basis. Typical transatlantic cockpit will be manned by a captain, first officer, flight engineer and navigator; extra pilot and engineer now carried will be eliminated because of shorter flight times. Average age of PanAm pilots is increasing, has reached about 36 yr. Age will not affect a pilot's assignment to jets; an older pilot makes up in planning what he might have lost in speed, according to Atlantic Division Chief Pilot C. S. Vaughn.

• **No flight simulator** for the 121 will be used; simulators for the bigger jets are being built and will be used. Ground school for engineers and pilots will require about 20 working days; flight phase will include at least eight hours of static training in cockpits to replace simulator training. Flight program will be about the same as with piston equipment, involving about 20 takeoffs and landings per man. One difference from piston training: no landings without flaps.

Many planned training maneuvers are still tentative pending Civil Aeronautic Administration decisions.

• **Instrument approach** plans have been designed to avoid interference with piston traffic, and at the same time to avoid jet holding below 20,000 ft. Plan devised for Idlewild Airport, not yet passed on by CAA, calls for an incoming jet to hold at 20,000 ft. in an area now available that is separate from the piston holding area. Plane is assigned a theoretical slot in the stack, and theoretically moves down the ladder

as altitudes become available, without actually entering the stack. At 2,500 ft., it joins the actual pattern at the localizer point and comes in to land.

• **Response to application** of power for go-around is slower with the jet; this is not considered a major problem as it can be allowed for.

The jets will utilize anti-skid brakes permitting application of any amount of foot power without incident.

• **Optimum cruise** technique with the jets would be drift-up as fuel is burned off, with a constant Mach speed. Air traffic control, however, won't be able to accommodate many planes using this method and step climb will be used most of the time. On long flights average true air speed will be 450 kt. Maximum altitudes probably will be 38-40,000 ft.; optimum altitude from a wind standpoint on the Atlantic will be about 32,000 ft. where the core of the jet stream is found.

• **Wearing of oxygen masks** by crews probably won't be necessary, Vaughn said, although regulations are still to be established. Drop-down masks will be available; pilots' hands will be freed by use of new radio units with buttons on the control wheel.

• **Communications** generally will be improved; higher altitudes will aid VHF communications and extend their range. Navigation and communication equipment initially will be about the same as at present, except for the Kollsman integrated flight instrument system with true air speed indicator. Conventional VHF dual communications units will use a new tail-mounted probe antenna, and PanAm is not sure what results will be; from Boeing reports, however, they are expected to be good.

• **Interiors will follow** a "long straight tube concept" with facilities at each end and centers kept free. Seats and bulkheads will be mounted on tracks with one-inch increments for fast change at transit stops. Passenger service pod including reading light, drop-down oxygen masks, public address outlet, air outlet also will move with the passenger seats. Boeing will install the flexible pod on the wall in the conventional location; Douglas is working on a pod that will be part of the seat and move with it. Passenger service will require one attendant for each galley unit on an economy-fare basis; there will be four galley units utilizing a new type of oven permitting service of 192 tourist-class meals in 36 min. The 121 will be operated without berth facilities, according to Ken Parratt, passenger service director. Short flight times are the chief reason.

• **Pressurization equipment** will not be powered by engine bleed, as is the case with the 707 prototypes. System would cause a problem in descent control. Also, engine manufacturer Pratt & Whitney Division of United Aircraft Corp. strongly recommended against it because synthetic lube oil will be used and if it starts cracking, toxic products are formed, Borger said. Instead, air driven compressors in three nacelles will handle the pressurization systems.

• **Impurities in water** used for injection can cut thrust 10%. The J57 engine uses augmentation water at the rate of about 40,000 lb. per engine per hour; some 5,300 lb. will be needed for the two minutes of thrust boosting needed during takeoff and up to 400 ft. altitude.

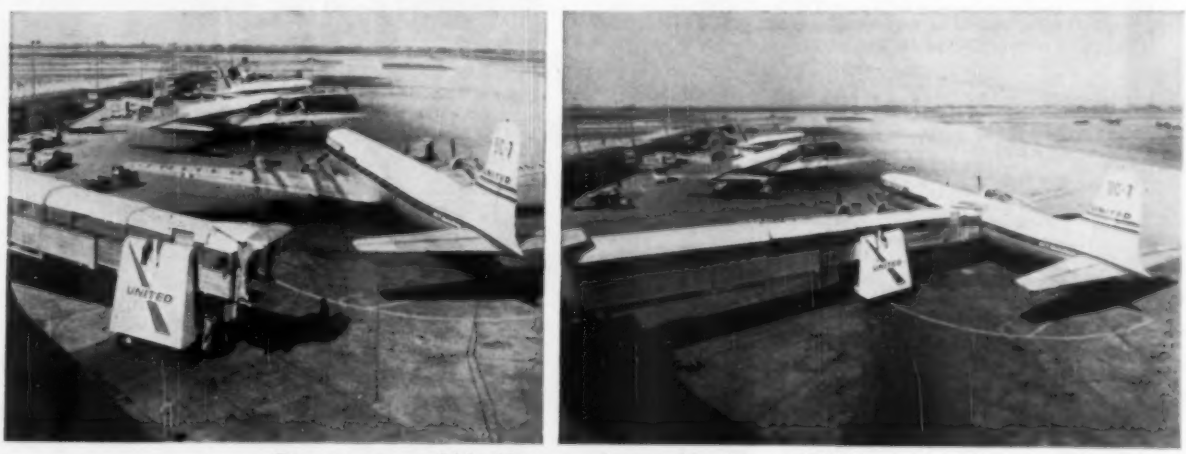
• **Kerosene** is about 5-6 cents per gallon cheaper than aviation gas, also provides 125,000 Btu. per gallon compared to 116,000 Btu. for the gas. Kerosene must meet a minus 58 deg. freezing point standard. Fuel temperature gauge in the cockpit is a new wrinkle with jets. Best emergency procedure to warm fuel is a long shallow dive, with the speed doing the warming up.

• **Full gross weight** of 246,000 lb. with the 121 on an 88F sea level day will require 9,800 ft. of takeoff runway with zero wind conditions. These are current figures and may show improvement.

• **Built-in ground servicing** facilities should include fuel, electricity, general purpose water and compressed air in that order of priority, according to Randall Kirk, manager of ground operation, Atlantic Division. Blast problem is "highly overrated;" wind velocity at the tail of a jet will be around 65 mph. at taxi speed. Not more than two ground people will work near the jet when its engines are running. PanAm assumes that noise level near the airplane on the ground will be from 100 to 120 decibels, about 10 higher than piston equipment. Kirk suggests the following scale of noise comparison: 120 db., artillery fire or thunder overhead; 110 db., rivet gun or elevated train on tracks overhead; 100 db., a boiler factory.

• **Meteorology** with the jets will require new pressure strata maps for operations at 30,000 to 40,000 ft. Company is asking for these maps at the 300 and 200 millibar level. Some information has been received from military sources on wind speeds, turbulence and other factors at these altitudes.

• **Baggage handling** will be improved by the larger baggage compartments on the jets, which are walk-in size. Because bags will be shelf-loaded and carried in and stowed properly, baggage damage and claims are expected to be greatly reduced. PanAm decided against preloaded baggage containers for its type of operation because of the weight and cost involved.



Passenger Walkway Installed at O'Hare

Positioned between aircraft and concourse, United Air Lines' Aero-Gangplank, a weather-shield walkway, has been installed at Chicago's O'Hare Field. First model of new device swings in arc (photo at left) to align with aircraft fuselage door (right). Walkway extends from retracted length of 55 ft. to maximum of 107 ft. Passengers enter walkway from second-story level. Power unit is in foreground.

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The activities referred to in this advertisement

Mil Plans Mi-1, Mi-4 Helicopter Changes

Moscow—Russia's leading helicopter designer M. L. Mil is considering radical modifications in his single-rotor Mi-1s and Mi-4s to make them more suitable for passenger transportation.

Biggest change may be replacement of the present piston engines with gas turbines.

Mil estimates that substitution of a suitable gas turbine engine for the Mi-1's 570-hp. AI-26V piston engine would reduce the helicopter's weight by at least 660 lb. and increase its payload considerably. Mil says "the gas turbine engine, being smaller in size, could be installed over the passenger cabin, thus enabling us to employ usefully the entire fuselage, which could then accommodate seven passenger seats.

"The same principle applies to the Mi-4. Using rotor, transmission and other units now in production, but replacing the present 1,700-hp. ASh-82V piston engine with a gas turbine powerplant, the Mi-4 could accommodate 18 passengers."

Another advantage of gas turbines, according to Mil, would be noise reduction. He points out that the twin-turbine engines on the Mi-6 are considerably quieter than the single piston engine on the Mi-4.

Mil frankly admits that the Soviet civil airline Aeroflot is not enthusiastic about using helicopters for passenger and mail transportation or for agricultural and forest protection purposes "because they are considered too expensive." Aeroflot contends that the initial cost of the craft is still great, while overhaul and depreciation periods are comparatively short.

Overhaul Time Doubled

This is the case despite Russian claims that time between overhauls on the Mi-1 and Mi-4 has been doubled since they first appeared in quantity in 1950 and 1952 respectively. Mil, who is the USSR's number one helicopter salesman and promoter as well as designer, says there is no reason why the period between overhauls on the Mi-1's engine cannot be further lengthened and adds:

"Depreciation costs can also be lowered so as to reduce operating expenses. Experience in the far north shows it is entirely practical to increase the Mi-1's utilization to 600 hr. annually.

"Original cost of the helicopters could be cut in half if production were increased—thereby lowering further the cost per flying hour."

Mil already has disclosed plans for getting maximum utilization from the Mi-1Nkh by using it in agricultural and forestry work during the spring and fall and for carrying passengers and mail during the summer and winter.

In its agricultural version, the Mi-1Nkh carries up to 880 lb. of chemicals. Mil argues that for forest work and for dusting vineyards, orchards and cotton, the Mi-1Nkh is more economical than an airplane.

An agricultural version of the Mi-4 also has been tested "with encouraging results."

Farm Use

Mil points out that Aeroflot airplanes employed in agriculture and forestry work often require the preparation of temporary airfields "upon which much money is spent. At the same time, the effectiveness of sowing or dusting from a helicopter is greater than from an airplane.

"However, despite these advantages, neither the USSR Ministry of Agriculture nor Aeroflot's State Scientific-Research Institute shows any noticeable interest in using helicopters for such necessary types of work."

Mil also thinks Aeroflot should show more enthusiasm over using helicopters for short-haul mail routes.

The Mi-1's mail payload, he declares, can be raised to 660 lb. and the craft's gross weight increased to 5,280 lb. while observing the prescribed centering limits.

"It is true that for runs over local routes the Mi-1's range is frequently insufficient. Ordinarily, the length of provincial airmail loops is up to 600 kilometers (373 mi.). Long flying ranges are particularly necessary in the far north.

"Improving the helicopter's range would undoubtedly increase Aeroflot's interest in the craft. Therefore, an auxiliary fuel tank has been designed for installation on the Mi-1Nkh which permits boosting the range by 170 kilometers (106 mi.)."

Citing the growing use of helicopters for urban passenger transportation in the U.S. and on Europe's Paris-Brussels-Rotterdam run, Mil said that Soviet rotary wing craft should be employed under similar circumstances as well as in areas without adequate roads and airports.

"The Mi-4P is already being used successfully for carrying passengers in mountainous and coastal areas. This model machine has a cabin accommodating eight persons, a lavatory, wardrobe and baggage compartment.

"Our design bureau has worked out plans for a 10-place version of the Mi-4P which has a range of up to 400 kilometers (248 mi.).

"Widespread utilization of this model would obviously enable Aeroflot to reduce its helicopter passenger transportation costs."

Soviet Coaxial Rotor Helicopter Seats Four

Soviet Kamov Ka-18 four-seat helicopter (AW Aug. 12, 1957, p. 33) called the Flying Car may be used on local Russian air routes. Fuel tank carries sufficient fuel for a 4 hr. 30 min. flight. Coaxial rotors have three blades. Helicopter has a 250 hp. powerplant and a cruising speed of 75 mph. Vehicle may be used over rough terrain, in agricultural role.

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(Booster engine (left), Sustainer engine (right), shown actual size.)

SHORTLINES

▶**British Overseas Airways Corp.** reports a 30% increase in bookings for summer transatlantic flights over the same period of last year. BOAC attributes the increase to new economy class fares effective April 1 with over 60% of the total in this category. BOAC is scheduling 32 weekly flights from New York to England and for the first time, daily service from Boston to Britain.

▶**Civil Aeronautics Board** has suspended a United Air Lines proposal for coach fares over five routes which would have been $1.00 higher than regular coach fares. Routes involved were Chicago-Cleveland; Chicago-Detroit; Detroit-Philadelphia; New York-Boston and Portland-Seattle.

▶**Ini & Cia, S. A., Aerolinas** (Argentina) has been recommended by a Civil Aeronautics Board examiner for a foreign air carrier permit between Buenos Aires and Miami. Ini has applied for scheduled service from Buenos Aires to Santiago and Antofagasta, Chile; Lima, Peru; Guayaquil, Ecuador; Panama City and Miami. The company proposes to offer tourist service using Douglas DC-4 aircraft operating on a twice weekly basis. One way fare would be $235 and round trip $438.

▶**KLM Royal Dutch Airlines** plans to double its freight capacity next fall with three Lockheed 1049H Constellations. The airline's current outbound transatlantic capacity is just less than 500,000 lb. per month. Introduction of the new equipment next fall would bring the capacity to nearly one million lb. each month.

▶**North Central Airlines** reports gross revenues of $10,801,995 for 1957, 35% above 1956. North Central President H. N. Carr credited the increase to substantial increases in all classes of traffic. Net earnings, after tax credits, were $80,791 as compared with $34,176 in 1956.

▶**Northwest Airlines'** Board of Directors has declared a dividend of 20 cents a share on common stock and a regular quarterly dividend of 28¾ cents a share on 4.60% cumulative preferred stock payable May 1 to stockholders of record at close of business on April 18.

▶**South African Airways** has ordered three Boeing 707 airliners for use on SAA's service between London and Johannesburg, S. A. The airline expects delivery to begin in July, 1960.

AIRLINE OBSERVER

▶Soviet Union's attempts to sell Russian jet transports to Syrian Airways Co. and Egypt's airline, Misrair, have been rebuffed. The two carriers, which will be merged according to plans of the new United Arab Republic, are interested in the Caravelle, Comet 4, Vickers Vanguard and the Lockheed Electra. They have considered the Russian transports but are finding it impossible to get performance figures on which they can evaluate operating costs. When the carriers ask for data on the service life of components, the Russians answer by promising to give the companies all the spares they need. On the subject of parts repairs, the Russians brush this off with assurances that parts requiring repair will be replaced by new parts.

▶**Although air crew cutbacks are expected to accompany the introduction of jet transports, one major carrier forecasts that all furloughed crew members who express a desire to return will be rehired within one year of the beginning of full-scale jet operations. According to the airline's projections, new hiring will begin within two years. The forecast assumes that traffic will continue to increase according to historic patterns.**

▶Civil Aeronautics Board has denied a request by the Air Transport Assn. to change the effective date of a regulation requiring the installation of flight recorders on large aircraft certificated to fly above 25,000 ft. from July 15, 1958, to Oct. 1, 1960. ATA charged that year-long tests proved present flight recorders to be inadequate for analysis of near-miss and other incidents. CAB claims that "critical timing" of the introduction of jets dictates that flight safety will not permit any delay in the use of any available tool.

▶**American Airlines will be the first to operate coast-to-coast jet transport flights "with service between the East and West Coasts to begin before the year is out," according to American President C. R. Smith. Smith also said in the company's annual report that a "limited number" of Electras will begin service before the end of the year. The airline has 35 Electras and 30 Boeing 707s on order.**

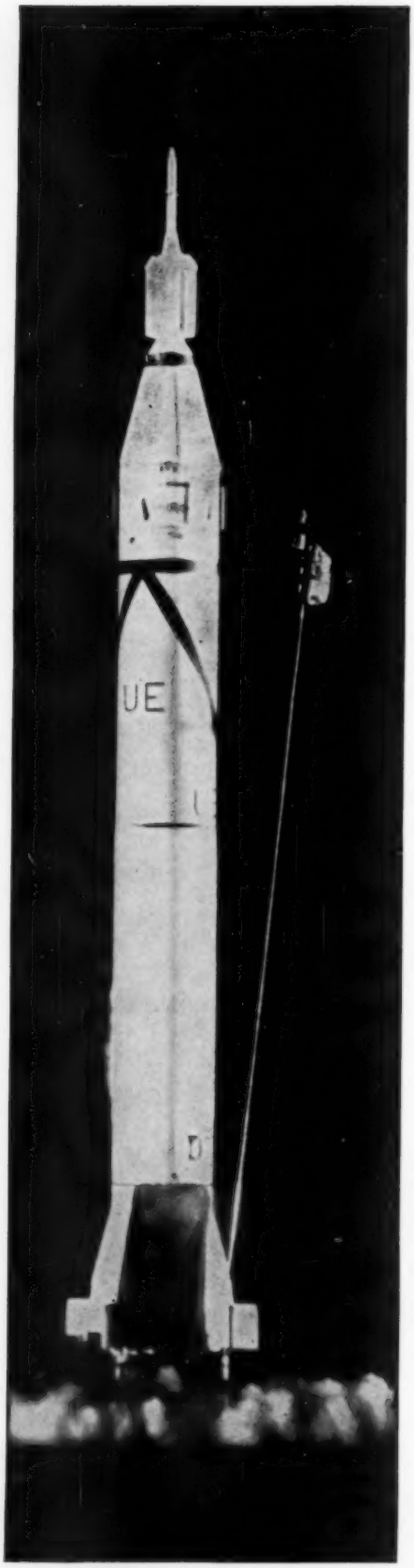
▶Chicago Helicopter Airways has set a sales target of 110,628 passengers for 1958, with a peak month of 15,770 passengers established for October. The airline carried 55,314 passengers in 1957. Meanwhile, Civil Aeronautics Board has disclaimed jurisdiction over an agreement between the carrier and Sikorsky Aircraft for the exchange of three of CHA's S-55 helicopters for two S-58Cs owned by Sikorsky. The exchange is expected to improve Chicago's operating efficiency and provide the desired capacity.

▶**Mohawk Airlines has retired two DC-3s, first voluntary retirement of DC-3 equipment by an existing local service airline. Mohawk's fleet now consists of 11 Convair 240s, nine DC-3s.**

▶Long-range capabilities of Russia's new Il-18 Moskva turboprop transport were demonstrated last month when the 78-passenger plane flew the 2,500 mi. distance from Moscow to Irkutsk in 6 hr., 45 min. Average speed exceeded 373 mph.; cruising altitude was 26,250 ft. The trans-Siberian flight marked the completion of the Il-18's factory tests.

▶**Mishandling of passengers has resulted in the introduction of two bills in the House designed to protect passengers against over-sales and delayed flights. One bill would permit overbooked passengers to bring action against an airline in any U. S. district court for sums sufficient to cover damages, plus twice the amount of the fare paid or $100, whichever is greater, and reasonable attorney and court costs. Other bill would establish a priority for passengers, whose flights have been delayed or canceled, on other flights of the same carrier to the same destination.**

▶Civil Aeronautics Board last week approved the new International Air Transport Assn. fare level on South Atlantic routes. The new rates, to become effective before Oct. 31, increase present first-class and tourist rates 3% but provide a third "special" tourist fare that is $65 less than standard tourist fares. Earlier, the Board approved the third-class "economy" fare on North Atlantic routes (AW Mar. 24, p. 33).



Republic Stainless Steel Circles the World

When "Explorer I" was successfully placed in orbit by the U.S. Army from Cape Canaveral on January 31, a new era was opened for the use of Republic ENDURO® Stainless Steel.

Vital instruments in the nose section of the satellite are protected by a cone of stainless steel produced by Republic. This nose cone was fabricated from Type 430 by The Lodge and Shipley Company, Cincinnati, Ohio, using the Floturn Process. By flow-turning, the wall thickness of the cone can be increased in specific areas to comply with design requirements of high temperatures or stresses.

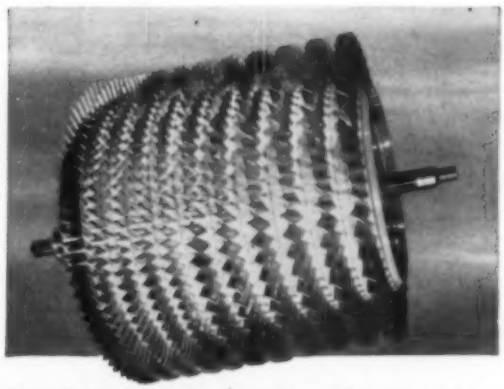
Stainless Steel is highly ductile. It is readily formed into desired shapes by cold-forming, drawing, and bending operations. It provides low thermal expansion and is highly resistant to atmospheric corrosion, erosion, and oxidation at high temperatures.

Republic is the world's largest producer of stainless, heat-resisting, and alloy steels. As rapid developments in the fields of supersonic aircraft and missiles increase demand for these high-strength, select formula steels, Republic is keeping pace through research and new production facilities.

Our metallurgists and engineers are always available, without obligation, to work with your personnel in using Republic Stainless Steels, Heat-Resisting Steels, Alloy Steels, and Titanium to best advantage. Check and mail the coupon if you would like a Republic specialist to call at your plant.

Official U.S. Army photograph shows launching of Jupiter-C Missile and "Explorer I" Satellite from Cape Canaveral, Florida, 10:48 PM, EST, January 31, 1958.

"Explorer I" is positioned on spin launcher. The satellite is spin-stabilized in much the same manner as a rifle bullet. Rotational spin of more than 700 RPM was started on the ground before the satellite was launched. In this Official U. S. Army photograph, the striped area at the top of the Explorer indicates the nose cone fabricated from Republic ENDURO Stainless Steel, Type 430.



REPUBLIC ALLOY STEEL provides high strength and dependable toughness in jet engine compressor rotor discs. In Pratt & Whitney's J-57 jet engine, Republic Hot Rolled Alloy Steel, AMS 6415 (AISI 4340), furnishes the highest strength values—plus an exceptionally high strength-to-weight ratio that permits the design of thinner, lighter sections to save weight and hold down size without sacrifice of strength or safety. The discs are machined from forgings by the Jet Division of Thompson Products, Inc. Forgings are supplied by Wyman-Gordon Company.

REPUBLIC TITANIUM is currently being used for many applications in both aircraft and missiles. Because of its high strength and weight saving factors, titanium has replaced other materials normally used for firewall and nacelle construction. In missiles and rockets it has almost unlimited applications. Titanium's extremely high corrosion-resistance makes it attractive for tanks to hold acids used in combination with missile fuels. Nitric acid, for example, has negligible effect on titanium. It is practically immune to salt water and sea air corrosion. Send coupon for more facts.

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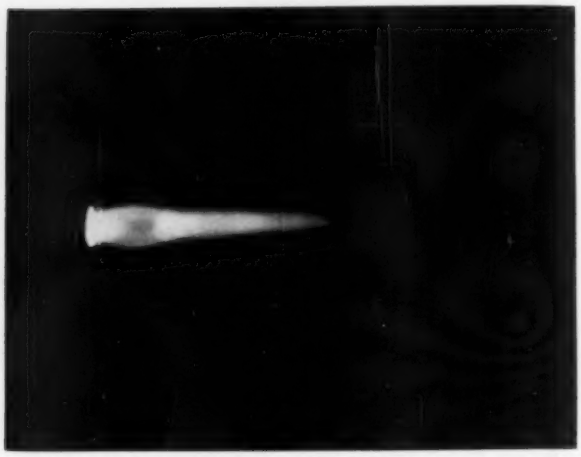
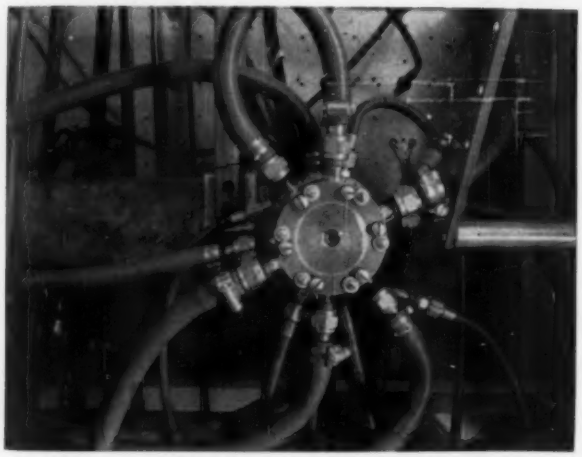




HIGHLY ionized plasma jet with pinched effect at nozzle is studied at Giannini Research Laboratory (left). Continuously operated plasma generator (right) on torque stand is used in propulsion studies at Giannini. Specific impulses as high as 600 sec. were revealed.

USAF Directorate Backs Space Study

By Irving Stone

Pasadena, Calif.—Basic research leading to developments in space technology is being stimulated by Directorate of Advanced Studies, Air Force Office of Scientific Research.

This approach, emphasized by Directorate of Advanced Studies early in its existence, is the key effort in its overall mission to sponsor studies in broad areas indicating potentials leading to development of practical applications in future Air Force operational categories.

Research the directorate is supporting relates to three main areas:

- **Space environment** exploration.
- **Space vehicle** components.
- **High vacuum** conditions.

Despite successful out-of-atmosphere soundings over the past few years, problem of progressing farther into space and returning information or physical equipment still presents formidable hurdles which must be topped to pave the way for Air Force operation in this new environment. Scientists and engineers concerned with space technology all agree that it will not be possible to blast into this environment without extreme preparation. This makes preliminary space exploration a top priority factor. Some key data-gathering categories the directorate is sponsoring or projecting through contractors, include:

- **Number, size and velocity** of meteorites and effect of impact on materials likely to be used in space exploration.
- **Intensity of magnetic** fields in space regions expected to be operational areas in the relatively near future.
- **Electron distribution** in space, a condition which will affect radio communication in both unmanned and manned vehicles.
- **Cosmic ray intensity** in regions beyond earth's cover.
- **Moon environment** and surface characteristics. These are considered essential for preliminary lunar exploration, leading to placing instrumentation on the moon or establishing a base there.

Project Farside

Initial practical implementation for gathering data in some of these research areas is Project Farside which has been sponsored by the directorate and conducted under contract by Aeronutronic Systems Inc.

Farside Phase I (AW Oct. 28, 1957, p. 31) has been a tremendous jump into space technology regime. Vehicle employed was the first to carry instruments to extreme distances, comparable to earth's radius.

One of the key aims of Farside was to evolve vehicles which could be built in quantities at small expense to point the way to future economics in exploration. Cost for designing, building and launching six vehicle systems under Phase I was less than $1 million. This included balloons for launching the vehicle at 100,000 ft., the four-stage rocket vehicle, instrumentation and other factors. Altitude reached—higher than with any other projectile previously launched—was at least 2,500 mi.

Probably three of the vehicles reached

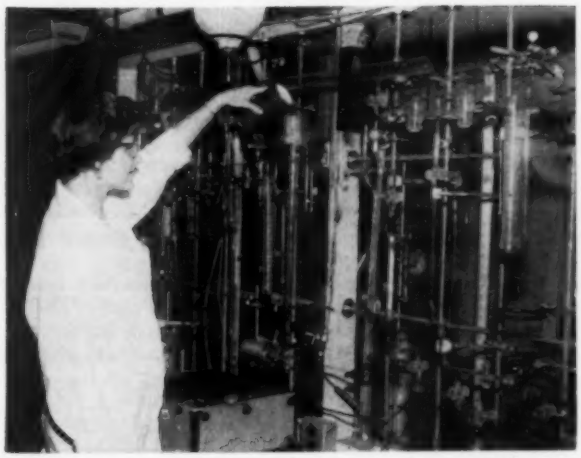
Directorate of Advanced Studies

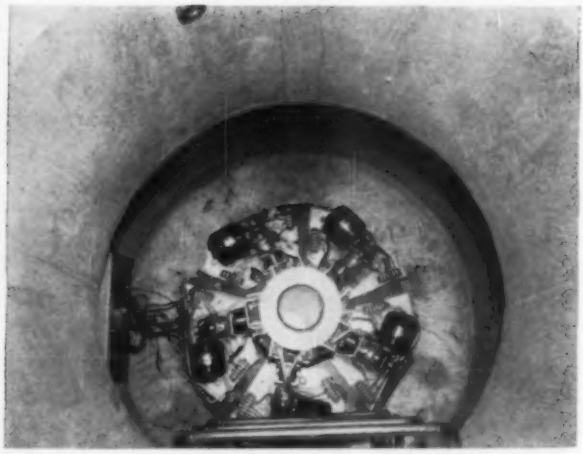
Directorate of Advanced Studies, activated in August, 1955, presently is monitoring 27 research projects aimed at establishing fundamental store of knowledge to speed future ventures into space and is evaluating numerous proposals for expanding this information.

Another prime interest is to encourage symposiums in astronautics, gathering top authorities in this field. First symposium, in 1957, was sponsored jointly by the directorate and Convair Division of General Dynamics Corp. (AW March 4, 1957, p. 103). Second, under sponsorship of the directorate and Institute of the Aeronautical Sciences will be held in Denver, April 28-30.

Supporting its important space technology studies with relatively small funding, the directorate carries out its work with four key staff members. Director is Dr. Morton Alperin, deputy director is Lt. Col. C. W. Craven, research administrator is Maj. E. J. Davis, and civilian research administrator is Charles B. Jordan. (Dr. Alperin is in photo on opposite page.)

It is one of seven directorates of Air Force Office of Scientific Research, commanded by Brig. Gen. Hollingsworth F. Gregory, which functions under Air Research and Development Command, commanded by Lt. Gen. Samuel E. Anderson.





APPARATUS for collection and identification of free radicals photochemically produced at Aerojet-General Corp. is at left. Kilocurie cobalt-60 irradiation facility (right) is viewed from above at Aerojet-General. Photo shows "hot" cell and cobalt positioning mechanism.

this height, perhaps another reached the full 4,000 mi. goal.

Tricky design, operational, and data-gathering problems were solved in Farside Phase I or solutions were indicated for cranking into future space-probing vehicles:

- **Vehicle structure** and components withstood accelerations as high as 200Gs.
- **Special timing** circuits were devised for exact ignition of rocket stages.
- **Vehicle was stabilized** outside the atmosphere by introducing spin of 480-600 rpm. by canting first stage nozzles.
- **Total of only 4 lb.** for payload required special miniaturization of instrumentation and telemetering transmitter. Magnetometer and transmitter were developed solely by Aeronutronic. Transmitter weighed only 12 oz., used very narrow band to obtain long distance with minimum power, was sealed and pressurized to avoid adverse effects of environment.

Cosmic ray counter was developed by Prof. Fred Singer, University of Maryland.

- **Engines were stock** items, but nozzles were modified to get maximum performance at extreme altitudes. Total actual burning time was slightly under 8 sec., and final burnout velocity was 26,000 fps. Effects of uneven burning or of one rocket being ignited before another in a cluster were minimized by directing thrust of each rocket through vehicle's center of gravity.
- **Cosmic ray data** obtained pointed the way to improved data-gathering approach for follow-up in space exploration. In Farside I shots, cosmic ray instrumentation was very dependent on voltage applied to the Geiger tube. As a result of environmental conditions, this voltage varied beyond limits initially set, rendering data interpretation difficult.
- **Magnetic field measurements** were intended to aid instrumentation development in connection with future research projects in the vicinity of the moon, but also aided in determining altitude of Farside vehicle.

Magnetic Variations

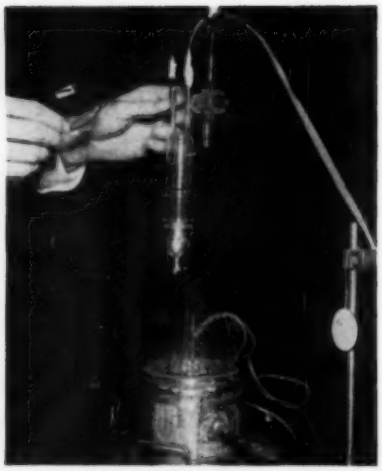
Measurements indicated that the magnetic field varies in accordance with theoretical predictions, that there are anomalies in the magnetic field, due to electron currents, which also were expected to be found.

Directorate of Advanced Studies is projecting studies for development of techniques for investigating meteorite characteristics. It is planning to sponsor work which would simulate meteorite particles in the laboratory and determine their effects on materials. Negotiations are under way with contractors to conduct these experiments. Meteorite measurement techniques expected to be developed in this investigation would be used in future research vehicles.

Plans for one of these vehicles, Farside II (AW Nov. 4, p. 27) are already completed, awaiting approval by Air Research and Development Command as a follow-up, by Aeronutronic, of Farside I. The Phase II vehicle, initiated as a preliminary study under Farside I project, is intended to place a payload in the vicinity of the moon, not necessarily for impact on the moon.

In addition to studying number, size and velocity of meteorites beyond the fringes of earth's atmosphere and in outer space, Farside Phase II project would also measure the moon's magnetic field, if any, with instrumentation developed during the Farside Phase I project. Also projected for inclusion

COMPOSITE photo shows Dr. Morton Alperin (left), director of Directorate of Advanced Studies, and Lt. Col. Russell Hedrick (center), commander of 4951st Air Force Support Squadron, conferring during recent Farside Phase I firing at Eniwetok. Dr. Ernst H. Krause, vice president in charge of research and development, Aeronutronic Systems, Inc., is at right.



CALORIMETER assembly, in conjunction with cobalt-60 gamma source, is used for formation of free radicals at low temperatures.

in Farside Phase II is measurement of electron densities between earth and moon.

Conceivably, the Farside II vehicle could measure moon surface characteristics if impact were achieved, but special instrumentation would have to be developed to measure surface penetration and other material characteristics.

Following the low-cost concept demonstrated in Farside Phase I, the Phase II vehicle would be a combination of off-the-shelf solid propellant rockets making a five-stage configuration.

Complete project, including 18 vehicles for preliminary test and final shoot, would cost about $8 million. Total payload would weigh approximately 25 lb.

Telemetry for the project is already designed. Transmitter weight would not exceed 10 lb.

Vehicle would include following stages:

- **Stage one**—four Thiokol Sergeants.
- **Stage two**—one Sergeant.
- **Stage three**—three Grand Central Rocket Co. units as used on third stage of Vanguard satellite vehicle.
- **Stage four**—single rocket of this type.
- **Stage five**—scaled down (6-in.-dia.) Sergeant.

Farside Phase II contemplates five steps encompassing preliminary testing and final shoot phase, as follows:

- **Step one.** Two vehicles would be used in this first preliminary test. Each vehicle would be composed of live stages 3 and 4, and dummy stage 5. At Eniwetok, in the Pacific, vehicle would be carried by a balloon to 100,000 ft. altitude and launched. Altitude expected to be attained in this trial is 850 mi. Purpose of these vehicle fringes would be to check out ignition characteristics, performance, separation techniques, and functioning of telemetry. Payload for this trial would only be 10 lb.
- **Step two.** This trial would incorporate live stages 3, 4, and 5, would also carry 10 lb. payload, would reach 3,300 mi. altitude, for similar checkout. Four vehicles would be used in this phase.
- **Step three.** This would be a ground launch, using a vehicle composed of live stages 1, 2, 3, and 4, coupled with dummy stage 5. Payload of 10 lb. also would be carried. Prime purpose would be to check ground-launch technique. Four vehicles would be used in this phase.
- **Step four.** Same as step three except that all stages would be live. Two vehicles would be used for this phase.
- **Step five.** This would be final phase, using all live stages as in step four, together with total payload of 25 lb. Six vehicles would be used in this final firing phase.

Vehicle Components

Directorate of Advanced Studies is taking the long-range approach to promote evolution of components specifically suited to space flight. Aim is to develop techniques, embodying novel scientific principles if necessary, to attain performance compatible with long, controlled travel in space.

Some of the prime work the directorate is sponsoring includes research related to:

- **High-specific-impulse** propulsive devices.

In this category Giannini Research Laboratories, Santa Ana, Calif., is conducting a program aimed at utilization of a high velocity plasma jet to produce propulsive thrust. Plasma is a mixture of ions, electrons, and, at times, neutral particles. Investigation includes various aspects of propulsion potential, such as acceleration and channeling of plasma jets by magnetic fields.

Also involved is a basic study of the energy exchange process between electric arc and gas flow. This includes cooling considerations of electrodes and chamber walls.

Fundamental investigation of electrical power sources for electrical thrust devices also is being conducted. This is aimed at harnessing such energy sources as nuclear reactors and batteries, generators using ionized gas moving against a magnetic field, solar energy, and atomic oxygen to drive a power generator.

In course of its studies, Giannini has demonstrated the feasibility of drawing power for auxiliary purposes from ionized plasma jets. Laboratory experiments have produced currents as high as 40 amp. for this purpose.

- **Use of ionized fluid** as propulsive medium.

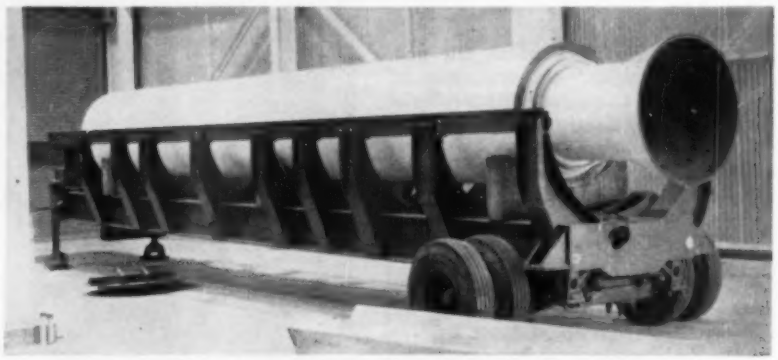
Problem involved is to separate ions from electrons and accelerate them separately by electrical means to extremely high velocities to obtain momentum changes from small quantities of mass.

Both North American Aviation's Rocketdyne Division and Aerojet-General Corp. are working in field of ion propulsion under contract from the Air Force unit.

Rocketdyne is conducting a systems-analysis type of research, while Aerojet's research is of a more specialized nature dealing with techniques for production of copious quantities of ions.

Studies thus far are all of a fundamental nature, but Rocketdyne already has proposed actual development of an ion rocket motor for laboratory experiments.

Rocketdyne systems-analysis research indicates that three parameters will determine the design characteristics of the ion engine. These are the ratio of accelerating voltage to effective atomic weight of propellant per unit charge, gross weight of the vehicle, and thrust-to-weight ratio. Ion thrust chamber itself basically could be a simple device consisting of an ion source and electron



Solid Propellant Rocket in Cradle

Large solid propellant rocket produced by Aerojet-General Corp. for U.S. Navy rests in trailer cradle at Sacramento, Calif., production center. This unit was successfully test fired at Aerojet's static test firing facilities at Sacramento. Picture gives idea of large rocket sizes possible in solid propellant rockets. Rocket was developed during Polaris program.

source, with accelerating electrodes. Design of the thrust chamber will demand compromise in the selection of accelerating voltage, propellant, and thrust-to-weight ratio of the vehicle, to achieve optimum balance between specific power demands, size, weight, and operating time of the rocket engine.

Ion Rocket Research

Productive areas of research directed toward achieving a successful high-thrust ion rocket engine specifically include high-specific-power electrical generators and heavy ion propellants.

• **Utilization of energy** contained in the upper reaches of atmosphere, such as 50-100 mi. altitudes.

At these heights, due to action of cosmic and solar radiation from outer space, atmospheric oxygen and nitrogen molecules are dissociated.

If these dissociated molecules can be recombined, large quantities of energy can be released for possible use as propulsive thrust. It is possible also that other planets, as well as earth, have atmospheres containing similar dissociated molecules and any scheme to recombine them might be useful to permit operation in region of these planets.

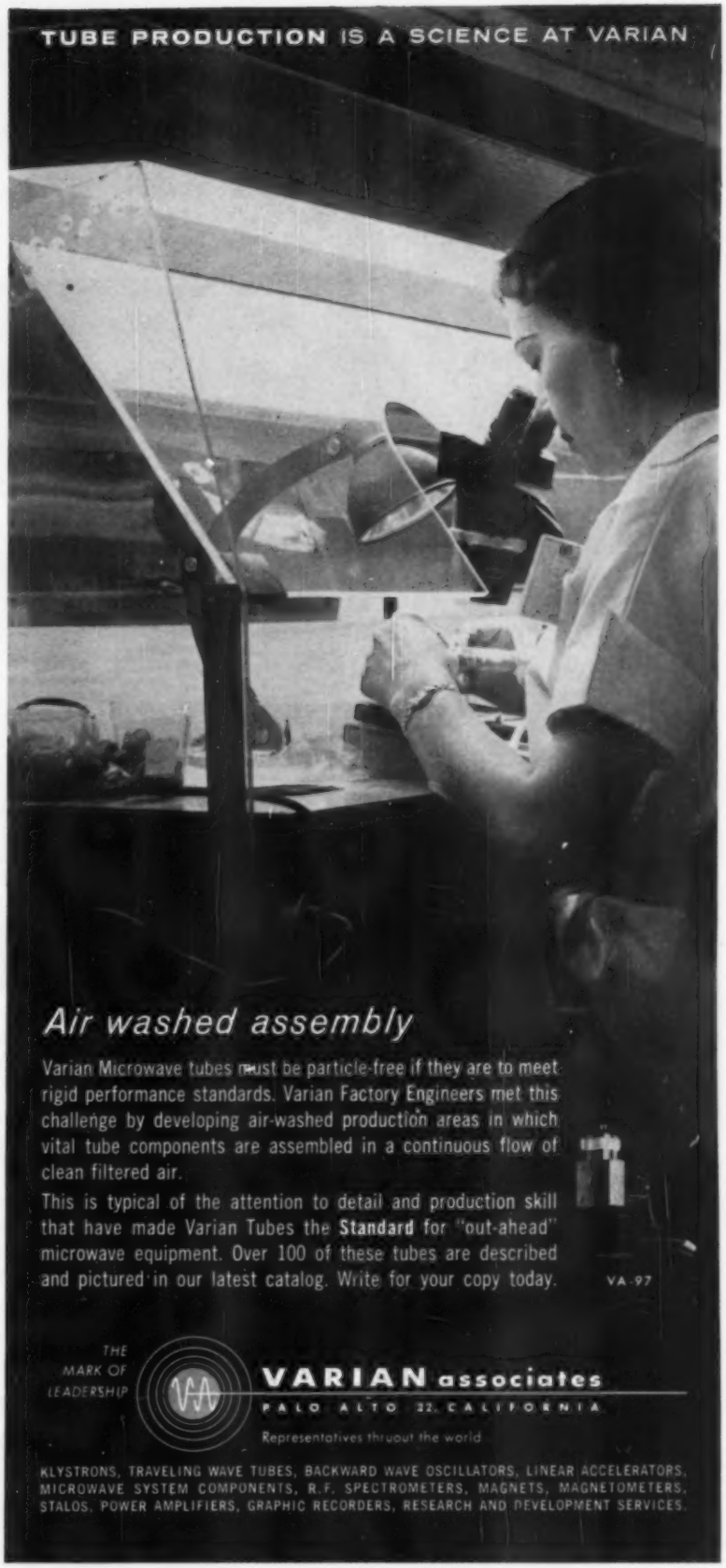
Aerojet-General Corp. is investigating, under contract with the directorate, theoretical and experimental factors relating to creation of a ramjet powerplant using recombination energy. Work was started about a year ago and initial contract will run until May, when it is likely to be renewed. Study includes methods, rates, and catalysts for recombination of atomic oxygen. To investigate the recombination process, it is first necessary to produce atomic oxygen from molecular oxygen. This includes use of shock tubes, discharge tubes, and application of high temperature and low pressure.

It is conceivable that by utilizing the recombination energy of the atoms encountered that sufficient propulsive force may be obtained to compensate for the drag due to the particles. Recombination might be accomplished by compression alone, depending upon flight speeds, but the most feasible scheme might be to use compression plus catalytic action.

Supplemental Thrust

It may be possible to use chemical hydrocarbon fuels to supplement the basic recombination process in order to obtain higher thrust for accelerating to escape velocities. It is believed that only relatively small quantities of chemical fuel in combination with molecular oxygen resulting from the recombination process would be needed to double the thrust resulting from the recombination process alone.

One of the potential uses of a recombination ramjet would be in a rela-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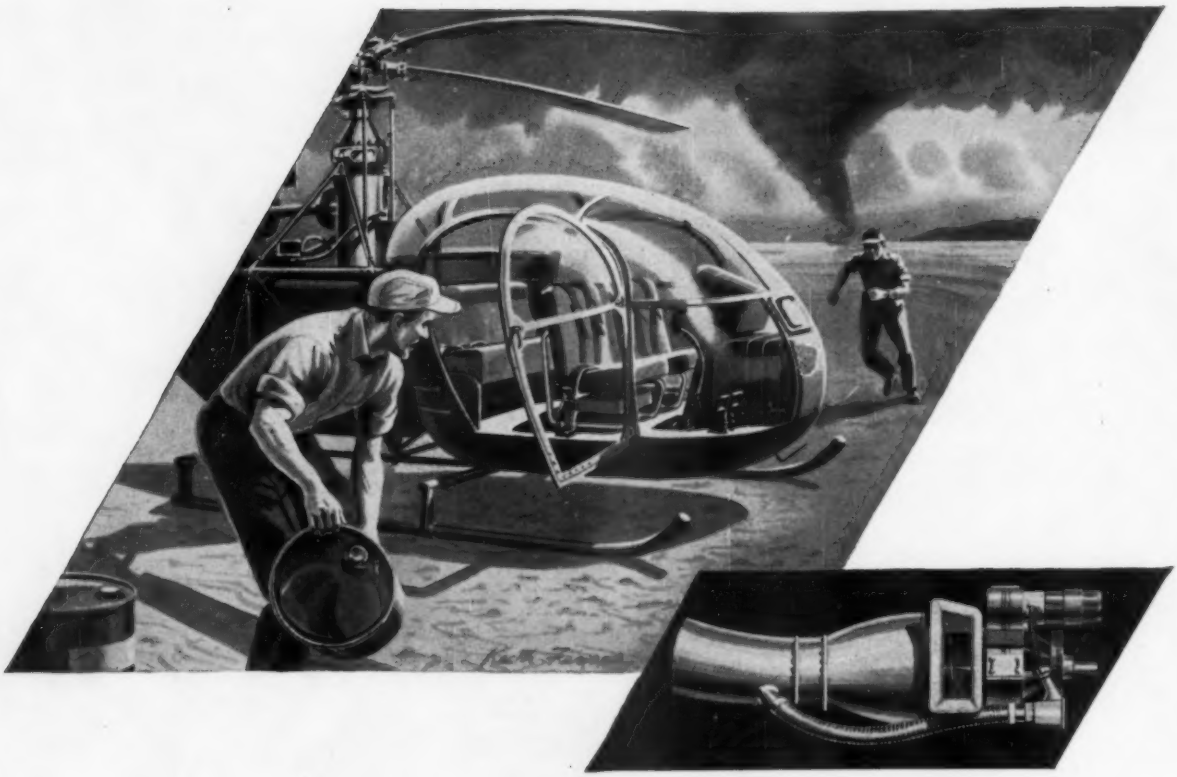

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tively low altitude satellite. It might also be used for the re-entry phase of a space vehicle, and conceivably as a "factory" for collecting and storing free oxygen and nitrogen atoms. Another use might be as a high-altitude signal reflector.

Sufficient research progress has been made so that very broad discussions regarding configuration of a recombination ramjet are underway. Only basic concepts are involved—details are necessarily still in a formative stage—since bulk of the effort is concerned with fundamental aspects of recombination process.

Powerplant conceivably might resemble a huge duct, possibly 100 ft. in diameter and 1,000 ft. long. Even at this stage of development, the 1,000-ft. length might be conservative for military application. Aluminum foil conceivably could be used as the material of construction but rigidity and temperature-resistance problems would be formidable.

• **Investigation of techniques** to produce and stabilize free radicals.

Aim of this research is to determine feasibility of storing these radicals and using the energy released by their recombination for propulsive thrust.

Aerojet-General Corp. and General Atomics Division of General Dynamics Corp. both are engaged in this work under contract with the Directorate of Advanced Studies.

Energies per pound of propellant storable in the form of free radicals will be two to five times that available from known chemical reactions, thus providing desirable specific impulses.

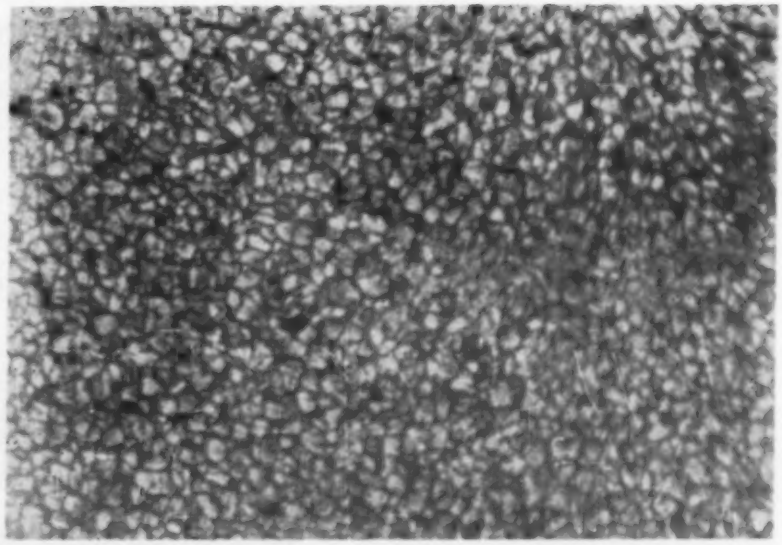
Free radicals under investigation include NH (Imine) and H. Techniques for creation of these free radicals include the use of gamma irradiation, photochemical decomposition, thermal dissociation and atomic beam.

Characteristic of these free radicals is that they recombine almost as soon as they are formed; hence, the big problem will be to stabilize them so they can be stored in a practical way for use in a rocket.

Free radical studies are still in their infancy. Thus far only minute quantities of free radicals (NH and H) have been stabilized for very short periods. But the reward for attaining such concentrations of energy appear so attractive that effort in this area will be accelerated to promote new concepts for forming and stabilizing free radicals.

• **Magnetohydrodynamics.**

In addition to propulsion potential, (ion or plasma), magnetohydrodynamics offers promise for magnetic control to reduce velocity of re-entry bodies to achieve very greatly reduced heat inputs. Magnetohydrodynamic drag may be effective for re-entry of satellites weighing about one ton or more.



Camera Details Sun's Surface Eddies

Sharply-detailed photograph of about 50,000 x 75,000 mi. of sun's surface is refinement of one of 8,000 35 mm. negatives taken by special telescope-camera designed by Perkin-Elmer Corp. (AW Oct. 28, p. 116). Camera was carried to more than 80,000 ft. by balloon to escape photo distortion of earth's atmosphere. Upon completion of photography, telescope-camera and associated equipment were parachuted to earth. Telescope has 12-in. aperture with effective focal length of 200 in. Two successful flights were made in paper-thin plastic Skyhook balloon, under Project Stratoscope, conducted for Office of Naval Research. Special precautions were made to protect camera and lens from solar heat and other thermal effects. Camera unit weighed about 300 lb. Spots in this photo are turbulent areas about 300-500 mi. apart.

Fundamental advantage offered by magnetohydrodynamics is that it becomes possible to exert body forces on an electrically conductive fluid (such as the ionosphere).

All previous methods of controlling fluid motion involve solid surfaces which push on the fluid boundaries. Since magnetohydrodynamic forces can act at a relatively large distance from the body containing the magnetic field coil, a larger volume of fluid can be acted upon than with an ordinary wing. It therefore becomes possible to produce larger lift coefficients than can be achieved with ordinary wings. In addition, ability to deflect the fluid at some distance from the body also affords protection from aerodynamic heating which would normally be encountered, thus reducing thermal effects.

Research in Progress

Avco Research Laboratory, a unit of the Research and Advance Development Division of Avco Mfg. Co., Everett, Mass., is conducting fundamental research in this field under contract with the directorate.

• **Novel ground-based** detection for locating vehicles in atmospheric fringe, 100 mi. and higher.

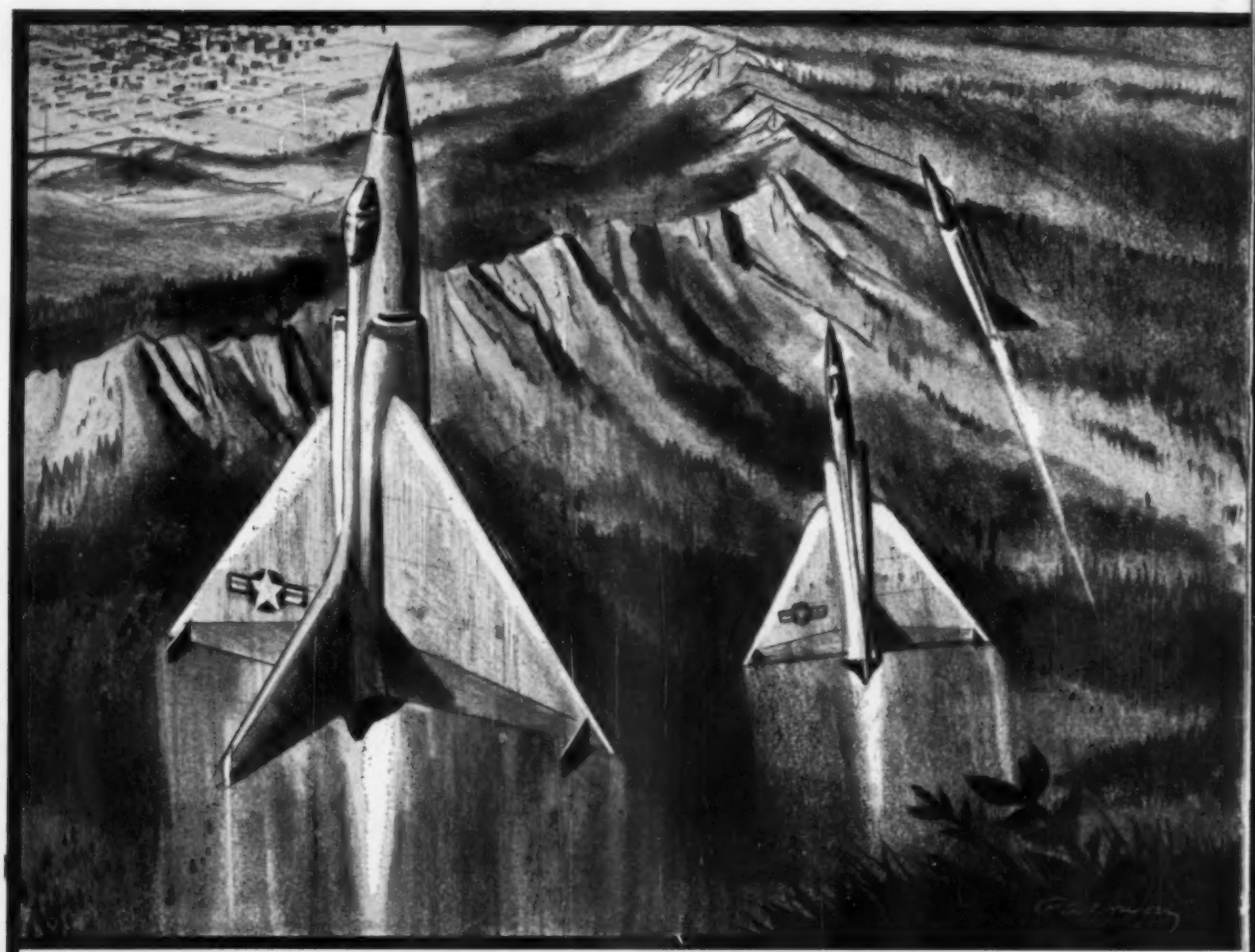
Research the directorate is supporting in this category is aimed at a system which does not require emission of signal from detecting apparatus (hence, unjammable), operates equally well regardless of size and velocity of target, and is capable of operating over a very large range, using minimum amount of equipment. Study is now in its second year, has already resulted in an experimental device which indicates big promise. Effort is now being directed at refinement.

This detection research is considered extremely important, particularly for military use, because present techniques have range and size-of-target limitations and use a pulse which requires relatively large power and which itself may be detected, hence, jammed.

Directorate of Advanced Studies is now evaluating a large number of proposals for research considered critical for pushing back basic barriers in development of space technology. Some key proposals it is considering include research related to:

• **Generation of hypervelocity** particles and their effect on materials, to simulate cumulative results of impact by meteorites in space. If small high velocity particles (artificial meteorites) can be created in the laboratory, the measurement techniques can be developed so that interpretation of meteorite impact effect on space vehicles can be made.

Methods projected to be used for propelling hypervelocity particles in the laboratory encompass explosive charges, including simple pellets and shaped



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The Ryan X-13 Vertijet®—which takes off and lands straight up and down on pure jet thrust—has opened the way for an entirely new kind of combat aircraft. In the words of a top air tactics expert, "Such vertical take-off jets can give us a tactical advantage never before realized... as revolutionary a change in aerial tactics and strategy as the jet engine itself."

This advantage can be spelled out with three words: *speed, maneuverability, mobility.*

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MANEUVERABILITY—The Vertijet's wings are designed for flying only—not for take-off and landing. Combat Vertijets will turn within one-fourth the radius of conventional fighters. And, they can hover or make the transition from vertical to horizontal—or reverse—at any time, and from low to high altitude.

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The Firebee is remotely controlled to perform any desired maneuver or evasive action.

The hot, high-flying Firebee, in full production at Ryan, has made more than *750* operational flights.

A Convair F-102 chases the Firebee high above Eglin Air Force Base.

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Army surface-to-surface guided missiles get their tremendous burst of power from liquid propellant rocket engines built by Ryan. Ryan has been building rocket engines on a production line basis for more than six years. The company's missile experience dates back to 1946, when Ryan designed and built the Firebird—the Air Force's first air-to-air missile.

Ryan has complete capability—from research and development through quantity manufacture—for complete rocket engines—both solid and liquid propellant types.

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These new automatic navigators represent just one area of Ryan's diversified capability in advanced avionics—including a wide range of systems for manned aircraft, guided missiles, helicopters and airships.

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charges; light-gas guns using hydrogen or helium as the propelling medium, and electromagnetic devices, such as induction units employing traveling magnetic fields acting on particles of magnetic materials, or electromagnetic repulsion devices employing magnetic fields acting on current-carrying particles or cartridges.

Studies would encompass various types of materials and various particle sizes and speeds.

• **Determination of electron** and ion density in space.

Knowledge of these factors is essential to understand the environment in which high altitude missiles and manned and unmanned vehicles must operate.

This information may also lead to relatively simple means for very long distance tracking and navigation.

Thus far, experiments to determine electron density have used radio waves reflected from moon's surface, and data gives cumulative density distribution.

The proposal anticipates use of a high altitude vehicle or possibly large meteors as reflecting mediums for generation of point-by-point information on ionic field in space.

• **Interaction** of free hydrogen and oxygen atoms with surfaces.

Practical benefit from this work is seen in the calculation of drag and associated aerodynamic phenomena during flight in extreme upper atmosphere (perhaps 60 to 100 mi. altitudes).

Free atoms impinging on a surface may interact with it in a very different manner than do molecules because of the possibility of recombination of atoms at the surface and chemical interaction of the atoms with the surface.

Study would involve fundamental experiments aimed at producing conditions which might exist in high upper atmosphere. This proposal has been approved and forwarded for contract negotiation.

• **Microwave emission** from rocket exhausts. Purpose of research would be to determine whether such emission exists. While considerable study has been done in the infrared and visible regions of exhaust spectrums, little or nothing seems to be known about emission in the microwave region. Obviously, determining existence of these microwaves in rocket exhaust could open interesting fields of military applications.

• **Practical ion source** for propulsion.

One proposal involves exposure of a heated metal having a high work function such as tungsten or platinum, to the vapor of an alkali metal such as sodium. When sodium collides with the surface, it tends to give up an electron to it so that the sodium atom is converted into a positive ion. This

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Higher . . . farther . . . faster – every advance in flightcraft brings a demand for improved optics for reconnaissance, aerial photography, infrared detection, bombing systems, instrumentation. Perkin-Elmer is meeting this demand with high performance optical elements produced in quantity at P-E's advanced production facilities in Norwalk, Conn.

Experienced in optical design and in combining optics with electronic and mechanical systems, Perkin-Elmer is producing derotation prisms for the MA-2 bombing system which it designed and which is now used in the B-52. These prisms resolve 4 seconds of arc, and Perkin-Elmer has been able to mass produce them on a steady production schedule. Aspherics, too, are being made in quantity as a result of exclusive production techniques developed by Perkin-Elmer in the past several years.

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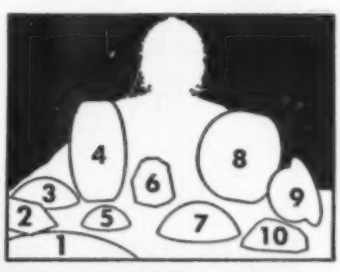

These are some of the optical elements Perkin-Elmer makes for military and industrial use: (1) Aspheric triplet corrector element for satellite tracking camera (2) 6" Porro prism for missile guidance systems (3) Aspheric lens for aerial viewfinder (4) Schlieren window (5) infrared dome (6) B-52 bombing system derotation prism (7) aspheric lens (8) element from 36" f/4 aerial photographic lens (9) periscope dome for B-52 bombing system, and (10) B-47 bombing system derotation prism.

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FIVE MISSILES *or drones* AT HIS FINGERTIPS...

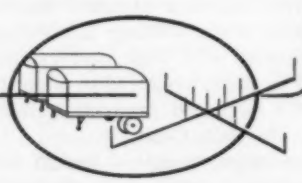
with Cubic MOPTAR

A SINGLE SYSTEM – Now, for the first time, as the result of six years of development and field evaluation, a single equipment (MOPTAR) is available for simultaneously tracking and, with modification, guiding five or more anti-bomber or anti-ICBM missiles. The cost of MOPTAR for tracking is, essentially, equal to that of a standard radar which has only single target capability. The accuracy of MOPTAR is approximately ten times that of radar. Vector miss distance is available from the system.

A PROVEN SYSTEM – Cubic MOPTAR (Multi-Object Phase Tracking and Ranging) combines Angle Measuring Equipment (Cubic AME) and Distance Measuring Equipment (Cubic DME) which have demonstrated their operational excellence at America's major missile ranges. In a recent missile evaluation flight, for example, a single Cubic AME installation provided high precision tracking data from launch to 1000 miles downrange.

A SIMPLE SYSTEM – The fundamental technique of both Cubic AME and Cubic DME consists of extremely accurate phase comparison. To measure range with Cubic DME, the phase of a demodulated signal which has been transmitted to an airborne vehicle and then retransmitted back to the sending station is compared with the phase of the signal which modulated the original transmission. In Cubic AME, the same retransmitted signal is received at several pairs of omnidirectional antennas on the ground. From the phase differences observed between the antennas of two pairs whose baselines are mutually perpendicular, it is possible to determine two direction cosines of the pointing vector to the airborne vehicle. In Cubic MOPTAR these two direction cosines and range are combined to generate highly-accurate real-time space-position information. Sampling and coding techniques provide multiple-target capability and countermeasure invulnerability.

A VERSATILE SYSTEM – Cubic MOPTAR is completely mobile. The electronic equipment is mounted in a single air-transportable trailer van; the fixed stub-type antenna system for a typical installation is presently mounted on the ground but can be modified to be mounted on four folding arms which are approximately 20 feet long when fully extended. The airborne transponder is a small, low-power unit which has been designed to operate satisfactorily in the most stringent missile environments.



"MOPTAR Developed for United States Air Force"

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basically is known as the Langmuir technique.

Another proposal for practical ion source is concerned with diffusion of atoms through "solid" walls to produce positive ions. Involved is a complicated interaction, not yet too well understood, between atoms and the wall. Contract for this experimental study already has been initiated.

Third scheme proposed involves determination of whether ions can be generated without application of electrical power in certain electrolytic solutions under proper conditions of temperature and pressure.

• **Feasibility study** for lightweight compact power sources in connection with ion or plasma propulsion. These lightweight units conceivably could be used as auxiliary power units in a vehicle which would use electrical or non-electrical propulsion system.

High Vacuum

The directorate has pioneered in high vacuum studies. High vacuum research laboratory (chamber) built by Litton Industries under contract for the directorate has demonstrated the value of such a facility to carry out research associated with space conditions (AW Oct. 14, 1957, p. 62). Indications are that this facility, as a research tool, will pay for itself many times in future developments.

Laboratory already has simulated altitudes of about 95 mi. with man enclosed, and with minor modifications may possibly simulate altitudes of 150-200 mi.

Trials in the chamber have demonstrated feasibility of man manipulating tools and instrumentation under high vacuum when he is properly protected by suitable garment as that developed as part of the overall research facility. Use of electron gun to detect very small leaks under high vacuum, comparable to space vehicle conditions, also has been demonstrated.

One of the big studies projected for the laboratory is investigation of metal surface friction phenomena under high vacuum, where lubricating surface films, including absorbed gases, are drawn off, leaving raw metal-to-metal (or other material) contact. This condition may affect operation of mechanical devices in space craft. Some preliminary research in this area has already been done in the chamber in its trial runs under initial contract with Litton.

Plans are being made to utilize the laboratory in the study of design parameters and performance of electromagnetic plasma accelerators for possible propulsion use. Chamber will offer a necessary realistic environment for study of this nature, possibly pointing out

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differences associated with experimental ground runs and near-actual environmental conditions.

Other plans involve use by other agencies of the chamber as an engineering development tool to vacuum-soak missile or satellite components in determination of dependability.

Similar plan is to use the laboratory for checking performance of the "space" suit developed for flight with North American Aviation's X-15 out-of-atmosphere research plane. This will provide opportunity to check out, under relatively safe conditions, the most critical part of the overall X-15 system—protection for the pilot.

French Firms Start IRBM Study Group

Paris—Group of French companies, mostly aviation and chemical, have banded together under the name "France-Rockets" to study problems of building intermediate range ballistic missile weapons in France.

New group is sponsored by French Defense Ministry. Idea is that since no one company has the facilities to tackle IRBM construction, the problem is best handled by pooling available resources. French used the same system in building the nation's first atomic center.

French group has sent a team to the U.S. to study IRBM development and fabrication programs. French Defense Ministry reportedly would like to have France-Rockets begin by building such weapons as the Thor or Jupiter, then branch out into an all-French design.

French companies belonging to France-Rockets include, in the aviation field, state-owned engine firm, Snecma; state-owned aircraft firms of Sud Aviation and Nord Aviation; private engine firm, Hispano-Suiza; private aircraft firms, Avions Dassault and Breguet; in the chemical field, Ugine-Nobel-Bozel; the construction firm, Creusot; and the big electronics firms of Thomson-Houston and C.S.F.

Atlas Base Construction Force Will Total 1,500

Cheyenne, Wyo.—About 1,500 employes of Convair Division of General Dynamics Corp. will be assigned here during construction and installation phase of nation's first operational missile facility at Warren AFB. Atlas intercontinental ballistics missile is scheduled for operation from Warren by fall of 1959. Convair said about 500 persons will form permanent operational force. Construction of two launch pads northwest of Cheyenne will begin this summer. Two more will be built southeast and southwest of the city.

Missile-type propellant tanks for the North American X-15 are built to withstand high pressures. Some fabrication techniques used on the X-15 developed from the firm's earlier work on the Navaho and F-100.

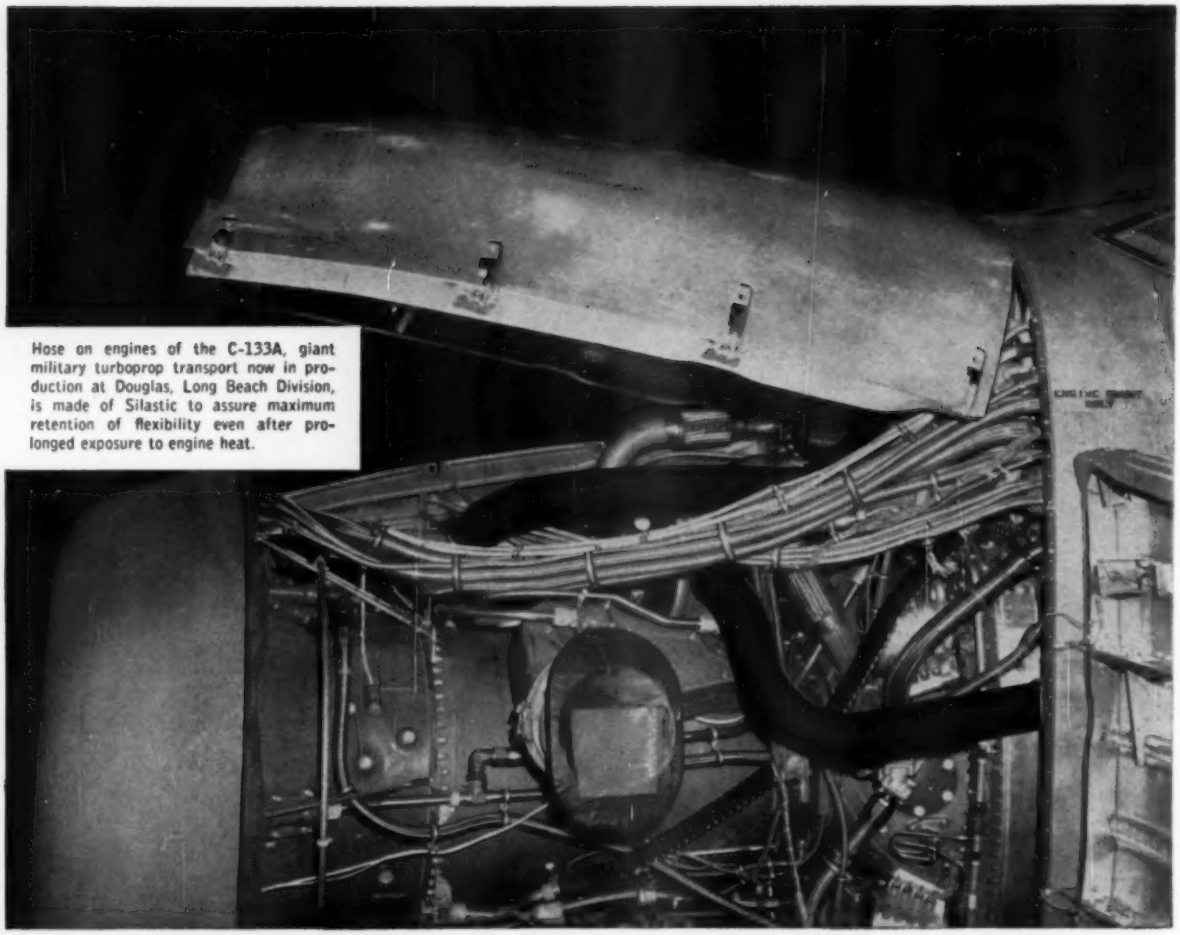
Engineers examine part of cylindrical fuel tank for X-15. To gain high structural strength, both automatic fusion welding and resistance welding are used.

Seamless weld in fuselage gets close check. All surfaces are of stainless steel. The X-15 will be subject to significant aerodynamic heating over entire skin.

X-15 Rocket Vehicle in Fabrication Stage

Hot nozzle exhaust is used to test wing leading edge configuration. In contrast to constant temperature testing of F-100 components, X-15 test temperatures must be reached within specified times.

High pressure lines running down side of fuselage are brazed for tighter joining instead of fastened with bolts or rivets. About 65% of components commonly fastened in current craft are instead welded in X-15.



Hose on engines of the C-133A, giant military turboprop transport now in production at Douglas, Long Beach Division, is made of Silastic to assure maximum retention of flexibility even after prolonged exposure to engine heat.

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First Mono-Atomic Ramjet Vehicle Designed for 59 Mi. Altitudes

By Michael Yaffee

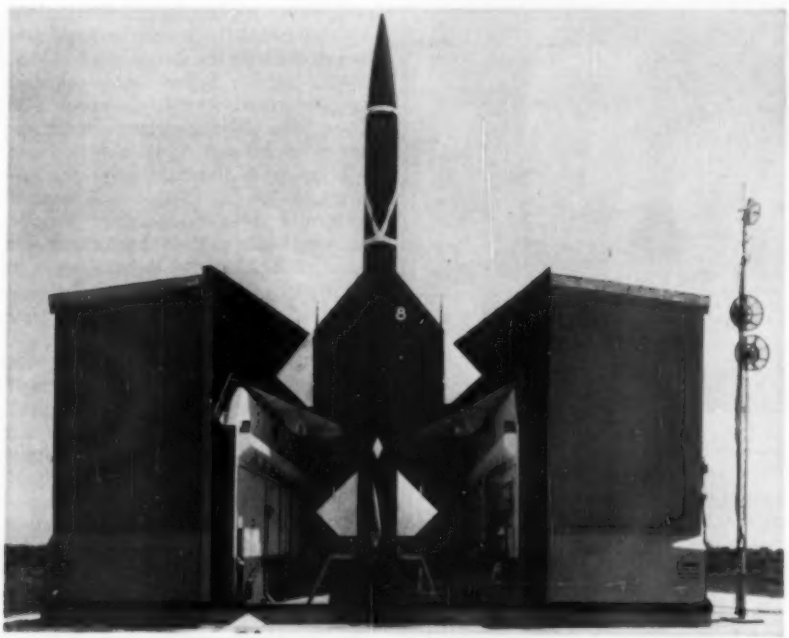
New idea in missile propulsion is commanding increasing attention from the Air Force. It is called a mono-atomic or recombination ramjet and derives its propulsive energy from the exothermic or heat producing recombination of free oxygen atoms in a narrow altitude band at around 60 mi.

Air Force Cambridge Research Center, current sponsor of the project, is expected to have the first mono-atomic-powered vehicle flying in about two years. The Center has contracted with Dr. Paul Harteck of Rensselaer Polytechnic Institute's chemistry department to continue development of his Hare recombination ramjet. And Dr. Harteck has brought in Dr. Rudolf Hermann of the University of Minnesota for studies on vehicle configuration.

Earlier, under contract from the Air Force Office of Scientific Research, Dr. Harteck and his assistant, Dr. Robert R. Reeves, Jr., demonstrated the chemical feasibility of using the oxygen atoms available in the upper atmosphere to propel a missile. More recently, their results were essentially confirmed by Sterges Demetriades and Carl Kretschmer of Aerojet-General Corp., who were working on a similar study under another AFOSR contract.

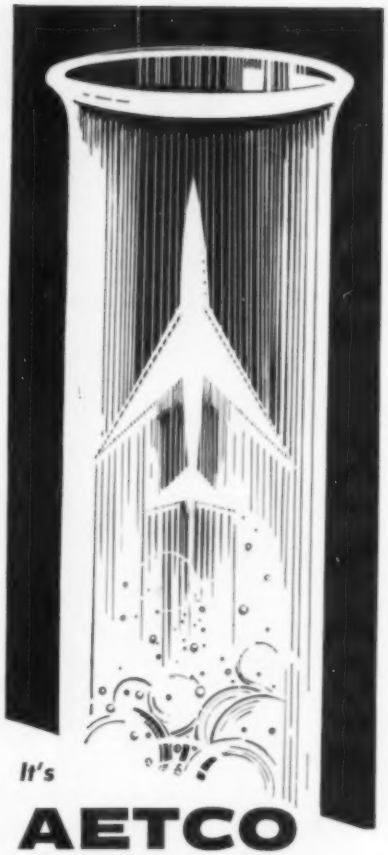
The fascination of the recombination powerplant is that it could operate forever, theoretically at least, on a free and virtually inexhaustible supply of energy. (In practice, the operating duration of the engine will be limited by the lifetime of the catalyst lining its interior wall. In the beginning, Dr. Harteck estimates that catalyst lifetime will be restricted to a matter of months.)

At altitudes above 37 mi. dissociation of oxygen molecules begins to appear. Ultraviolet rays from the sun cause this dissociation, forming in effect a reservoir of solar energy. Upon recombination into molecular oxygen, two atoms of oxygen yield 118 Kcal/mole O_2. From 59 mi. up, it is believed that all oxygen is dissociated. And at 62 mi. one cubic centimeter of atmosphere contains approximately 10^{-6} cal. of available energy in the form of dissociated oxygen molecules, according to estimates by Demetriades and Kretschmer. Visible proof of the existence of free oxygen atoms was provided by



Bomarc Automatic Hangar-Launcher

Boeing Bomarc IM-99 interceptor missile is fired from this automatic hangar-launcher. In test firings from Cape Canaveral, Fla., Bomarc has been held in readiness overnight waiting for a target to appear on radar far over the horizon. Then in 90 sec., hangar opens, missile is erected and fired. Aerojet-General rocket booster lifts missile off and it flies on its back until two Marquardt ramjets take over for Mach 2.5 interception flight. Size of the installation can be judged from Bomarc's 47 ft. length, 18 ft. span.



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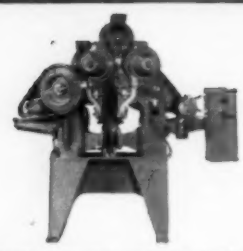

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a Cambridge experiment performed in March, 1956. Scientists released nitric oxide from an Aerobee-Hi rocket at an altitude of 63 mi. The nitric oxide catalyzed the recombination of the atoms into molecular oxygen with the accompanying release of energy in the form of visible light. The big problem was figuring out a way to use this energy as a practical propulsion source.

As early as 1953, Dr. Harteck suggested the use of a catalyst to recombine the oxygen atoms inside a flying duct configuration, similar in many respects to a ramjet. The recombination heat liberated within the missile would expand the incoming air, causing it to move out the rear opening with sufficient thrust to propel the missile.

After testing a number of possible catalysts, Dr. Harteck and Dr. Reeves decided that gold was the best material for their purposes. It catalyzed almost all oxygen atoms hitting its surface back to molecules, had the lowest heat loss through radiation and, as a result, produced the highest temperature of any catalyst at the comparatively low pressures that would be encountered by the missile.

Small Thrust

But even with the high efficiency of a gold catalyst, the maximum possible thrust would be small because of the low concentration of the available oxygen atoms in the upper atmosphere. This means that the missile itself must be extremely light. According to Demetriades and Kretschmer, allowable weight for such a vehicle is about .0002 lb./sq. ft. (10 mg. per square centimeter) of lift-producing surface.

Moreover, materials used in construction of the missile will have to withstand internal operating temperatures between 500C and 600C. And to avoid preheating the incoming air, the front part of the missile must be made of a material that has no catalytic effect on the recombination of oxygen atoms.

To meet all these conditions, Harteck and Reeves decided to use aluminum tubing in the construction of the missile, covering the aluminum frame with thin sheets of mica and gold-plating it as required.

The aluminum proved almost completely non-catalytic and could be obtained in tubing weighing about 100 mg. per meter. The mica was used because of its superior high temperature properties and the fact that it was available in sheets as thin as .0001 in. Structurally weak, the gold, needed for its catalytic effect, was plated by evaporation onto the mica.

Harteck and Reeves, however, neglected to take into account the differences in coefficients of expansion of the three metals. When the model was heated, the aluminum frame expanded

faster than the mica lining, and the thin mica, and gold-plate it directly. Altists now propose to use only one material for framing, either aluminum or mica sheets cracked. The RPI scienthough aluminum has much greater flexibility, they feel that the superior high temperature properties of mica are important enough to keep the more brittle material in contention.

Another important area in this development program that remains to be filled in is the question of how fast atomic oxygen recombines both in the atmosphere and on catalytic surfaces. Although there has been much theoretical work and lately some direct investigation of the subject, the recombination rates of atomic oxygen are still matters of speculation.

There are many ways in which oxygen atoms are consumed in the upper atmosphere. The most important of these is the formation of molecular oxygen (O_2) and ozone (O_3). The rates at which these reactions occur are important in determining the concentration of oxygen atoms at a given level in the upper atmosphere; i.e., the number of unreacted oxygen atoms left. And the concentration is important in determining the thrust that can be developed by a recombination engine.

Too, the reaction rates are important in the design of the powerplant. The efficiency with which the heat of recombination can be converted into thrust depends primarily on the recombination rates of atomic oxygen. And knowledge of this efficiency is a prerequisite to the design of a recombination ramjet.

Experimental investigation of these recombination rates is now underway at both RPI and Aerojet.

Harteck and Reeves have made several models of the Hare. But these models were designed primarily to test heating effects and materials of construction. Aerodynamic designs for the vehicle are now being studied by Dr. Hermann. The final configuration will be determined by simulated wind tunnel testing, in which water vapor, substituting for air, will be "pumped" by rapid condensation in a liquid nitrogen cold trap. (The reason for using this scheme is its comparative low cost.)

Regardless of its exact final shape, each vehicle must have an entrance port, a center reaction zone and an exit port.

The vehicle will probably have a supersonic inlet diffuser and a supersonic exit nozzle. To Harteck and Reeves this suggests a vehicle with the configuration of a cylinder or a rectangular duct, open and slightly tapered at both ends.

The vehicle will probably be collapsible or at least small enough to fit

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inside the protective nose cone of a carrier rocket. Without any means of propulsion in the lower atmosphere, the vehicle will have to be carried to operating altitudes and, because of its light structure, will have to be protected en route.

Actually, the experimental vehicle envisioned by Harteck and Reeves is a fairly small unit about 10 sq. ft. in cross section and weighing 5 oz. or less. It would operate at an altitude of 59 mi. and, with its internal temperature of approximately 550C, would have to fly at velocities of Mach 2 or less. Individual units could carry payloads of only a few grams. But a number of vehicles might be wired together to produce a useful though still small overall payload capability, Dr. Harteck suggests.

Will It Fly?

Harteck and Reeves state that a missile powered by the catalytic recombination of dissociated oxygen molecules is feasible. Their reasoning:

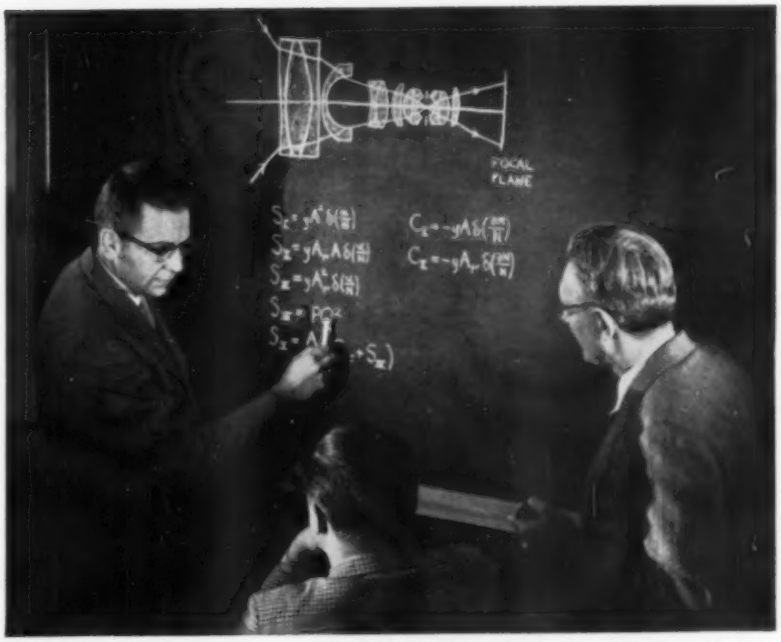
It is assumed that the vehicle will fly at an altitude of approximately 59 mi. where the total pressure is about two microns. At this altitude, one cubic meter of air will weigh 3.6 mg. and will contain 20% oxygen by weight.

If 50% of the oxygen is dissociated the weight of the free oxygen atoms will be 0.36 mg. This is equivalent to 1.3 calories of heat of dissociation for each cubic meter of air. (This checks fairly closely with the 10^{-4} cal. per cubic centimeter estimate of Demetriades and Kretschmer for 62-mi. altitudes. Not all the air will come into contact with the catalyst lining, so even with an efficient catalyst, only 1 cal. of the available heat may be recovered.

Assuming that the missile will be 10 sq. ft. in cross section and will fly at approximately 1,312 fps., it will take in 14,120 cu. ft. of air every second. From this 14,120 cu. ft., the engine should recover 400 calories of heat of dissociation. A reasonably efficient engine will convert 25% of the available energy to thrust.

But even assuming poor efficiency and radiation losses, say with only 10% conversion, and taking drag into account, the engine will produce a thrust and lift equivalent to 1.2 oz. (40 grams) and 6 oz. (200 grams) respectively. And it is possible to build a vehicle, the RPI scientists say, that weighs 15 oz. or less with readily available material.

Attacking the problem from a different angle, Demetriades and Kretschmer arrive at essentially the same figures, if not the same conclusion. They say that a 100% efficient recombination engine will produce a thrust of 40 dynes per square centimeter of inlet area at an altitude of 62 mi., and that it is possible to obtain an operable engine with a thrust of about 4 dynes per



Dr. Nisson A. Finkelstein discusses CinemaScope equation with Harold Straat and Donald Mortimer

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square centimeter of inlet area. For a ramjet cross section of 10 sq. ft., this works out close to Harteck's figure of 1.2 oz. (40 grams).

This thrust compares favorably with the minimum frictional drag expected at 62 mi. for a flight speed below Mach 10. And the thrust-to-drag ratio is the most important factor in determining the feasibility and usefulness of such vehicles. The Aerojet scientists, however, add that operation of the vehicle is "not easily practicable" because of the extremely light structural weight required.

Limited Speed

The theoretical task Demetriades and Kretschmer set for themselves was the development of a recombination ramjet that would fly at speeds close to Mach 20.

After an extensive investigation, they concluded that this was impossible.

The limiting factor here is the ratio of the ramjet's radius to length. In order to achieve a thrust that is larger than the drag, the length must be less than 0.7 as long as the radius. At the same time, for a catalytic recombination engine to operate at this altitude and speed, all incoming oxygen atoms must come in contact with the catalyst-lined walls, and this requires a length 57 times the radius. Obtaining recombination by compression is likewise unfeasible, say the Aerojet scientists, because there is no diffuser which can compress air 1,000 to 5,000 times with a length-to-radius ratio of only 0.7.

Harteck and Reeves agree that it would not be possible to fly a recombination ramjet at a velocity of Mach 20 or greater. But it seems very likely that such a vehicle will operate at Mach 2 or under and, even at these comparatively slow speeds, will prove a significant development.

The vehicle will be inexpensive to build and cost nothing to operate. Its light construction will be adequate for its low pressure operational environment. In all likelihood, the small payload and capability and limited catalyst lifetime can be increased. And, unlike an artificial satellite, it will not have to fly in a fixed orbit. But, most important, the recombination engine opens up a new and potentially significant area of propulsion, with the Hare leading the way to more sophisticated and practical powerplants.

Taking it into the interplanetary realm, Demetriades and Kretschmer also see some hope for their high speed recombination engine. On Mars, the presence of large amounts of atomic nitrogen (which has a heat of recombination almost twice that of atomic oxygen) would make it possible for the engine to propel a vehicle at sustained orbital speeds.

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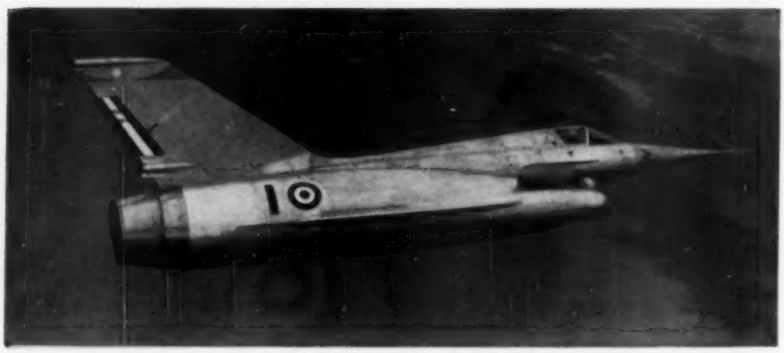
NORD-AVIATION 1500 Griffon II has increased inlet area for second phase of flight test program, and canopy redesign for high speed flight. Aircraft has reached Mach 1.85 in a climb with its ramjet developing 44,000 lb. thrust. Ventral fins used on Griffon I are omitted.

Griffon Support Survives Economizing

By David A. Anderton



NORD Griffon II in early stages of its flight test program pulls away under turbojet power. Inlet is original size used in Griffon I prototype; canopy is early design. Snecma Atar turbojet is used for takeoff, initial climbout; then ramjet powerplant is utilized. Prototype is result of five-year design program that started with glider with similar aerodynamic characteristics. Next phase will be installation of Snecma Super-Atar engine.

GRIFFON I made first flight Sept. 20, 1955, was powered by 9,700 lb. thrust (with afterburner) Snecma Atar 101-G (AW April 9, 1956, p. 31). Aircraft has ventral fins on tail. Gross weight of the Griffon I is about 9,000 lb. Aircraft was designed for vertical climb and a level flight speed of Mach 1.3. For takeoff, two Rato units can add 2,400 lb. of thrust each for a total of almost 14,000 lb. Cockpit is above straight-through engine intake duct.

Paris—France's only solidly supported research aircraft is the Nord-Aviation 1500 Griffon, a supersonic delta-winged plane powered by a turbojet and ramjet.

Like the ill-fated Leduc 0.22 (AW Nov. 4, 1957, p. 50), the Griffon has a single Snecma Atar turbojet hung in an annular duct that forms the ramjet. The turbojet is used for takeoff and initial climbout; the ramjet takes over from there. Now between phases in its test program, the Nord aircraft has racked up about 80 hr. of flight time during the past year, and has extended its performance envelope to a maximum of Mach 1.85 in a climb. At that speed, the ramjet was developing a thrust on the order of 44,000 lb.

That performance achievement has been the major factor contributing to continuation of the project after support for the Leduc 0.22 had been withdrawn.

Combination Powerplant

French faith in the Griffon stems from its concept of ramjet-turbojet operation, viewed by some technicians as the ideal compromise solution for high supersonic performance at altitude coupled with combat-useful ranges and endurance. For a long time that concept was solely exploited and backed by Rene Leduc, in a single-handed effort that French engineers recognize and applaud. Leduc's project held the engineering spotlight for a long time in the postwar years, and received strong tech-

nical–but weaker financial–support from the Air Ministry.

Then the Nord Griffon II entered the scene as a combination airplane hardly more than one year ago, making its first flight on Jan. 23, 1957. Behind it were some years of development and flight trials with turbojet power in its original airframe, with the delta-winged predecessors Gerfaut I and Gerfaut II, and a design family tree with roots that stretched back five years to a glider of similar aerodynamic shape.

This solid empirical and theoretical foundation has helped build the successes of the Griffon program. Its long-term future, like that of any French airplane now, is an uncertain one as long as the government continues to ignore financially the development of the many brilliant design concepts of the French aircraft industry. But for this fiscal year at least, its future seems assured.

Griffon Aerodynamics

The plane has mistakenly been called a canard because of the small delta surfaces forward on the fuselage under the cockpit. This may be a semantic nicety, but the general concept of a canard is that the forward surfaces are for control. On the Griffon, they are fixed surfaces–the French call them "the mustache"–and they are solely for preventing the nose-down trim change that a delta-winged airplane experiences as speeds approach the sonic.

The pilot of a delta usually has to crank in nose-up trim to counteract the natural tendency of the delta to tuck under at high speeds. The result is that the airplane is carrying several degrees of up-elevon in level flight, and the drag penalty is high. The Fairey Delta, according to one American test pilot, had to use seven degrees of elevon in its record-breaking highspeed runs and this definitely limited its speed.

With the Griffon's mustache, lift builds up on the forward surface as speed increases, and produces a nose-up pitching moment that counteracts the nose-down pitching of the airplane. The drag penalty of the thin, small forward wings is less than that of elevons at the necessary deflections.

The current Griffon is the modified first prototype that was powered solely by an Atar and was used to develop the aerodynamic layout. It has been considerably altered in the powerplant bay although not much anywhere else. Now officially the second prototype, it carries the type designation 1500-02.

Griffon has a delta main surface with 342 sq. ft. of wing area and a 60-deg. leading-edge angle. Wingspan is 26.6 ft. Lateral and longitudinal control come from elevons at the trailing edge.

Overall length of the Griffon, not counting the flight-test boom on the nose, is 45.8 ft. Gross weight is about 14,540 lb.

Cockpit is only a fairing above and forward of the ramjet powerplant installation, a huge annular duct that makes up most of the fuselage of the unusual-looking plane.

Inside this duct is a single Snecma Atar 101 E.3 turbojet rated at 7,725 lb. takeoff thrust under sea-level static conditions. The engine is a standard production unit like those installed in Sud Aviation's Vautours, with the exception that the nozzle area is fixed in the Griffon installation instead of being the variable type.

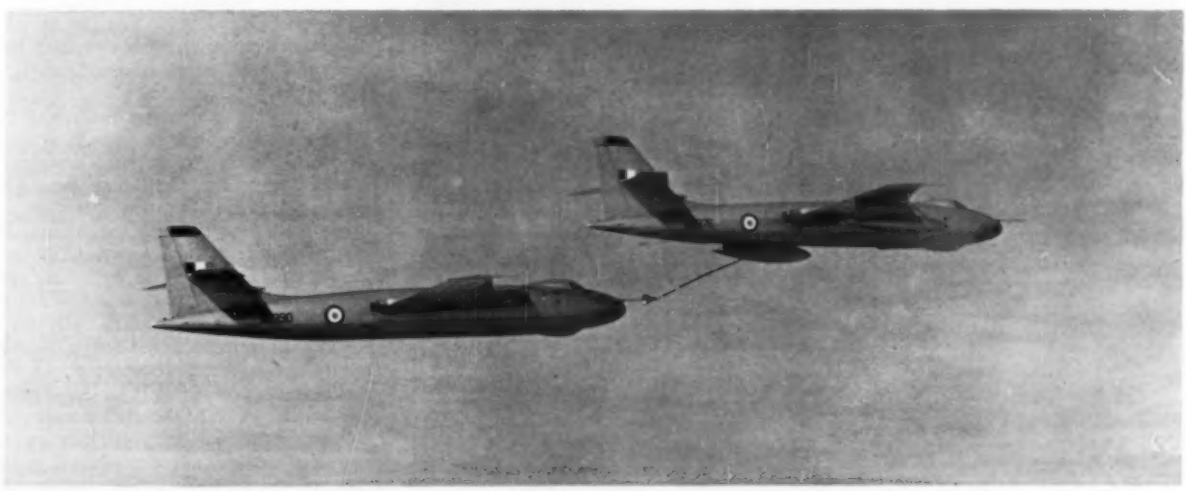
Air entering the inlet expands as it approaches the engine inlet face. There is no internal valving or diverting, and air that does not enter the engine simply bypasses it through the annular duct around the engine. Downstream of the engine's hot section, the ramjet begins where the annulus contains a ring of fuel injection nozzles. Further downstream is the flameholder, a double ring with a V-gutter cross-section, the open portion of the V facing downstream.

There is a much smaller annulus between the fuselage structure and the combustion chamber of the ramjet to shield the fuselage from the high-temperature burning inside the chamber. It discharges upstream of the main powerplant exhaust nozzle through a series of openings which can be seen around the tailpipe of the engine.

Fuel system, like the ramjet, is a Nord-Aviation development. The fuel pump is driven from accessory section of the turbojet and is capable of moving 10,560 gal./hr. Fuel is metered by a system including a computer with an avionic limiter. Fuel can be fed from tanks to either turbojet or ramjet or both, except for a single reserve tank for the turbojet alone.

Shock System

The Griffon air intake at first appears to be a simple pitot type with a normal shock at the lip. Actually the shock pattern is more complex, because of the bow wave from the cockpit nose and a secondary shock triggered by interaction in the boundary layer. This secondary shock and the bow wave make a



Valiant Modified for Refueling

Vickers Valiant swept-wing jet bomber conversion to aerial tanker can be accomplished in a matter of hours by installation of bomb-bay fuel tank, turbine pump and piping, and fitting of hose-drum unit in bomb bay. Receiver conversion, completed in even shorter time, consists only of fitting of probe. Drogue configuration is generously slotted cone coupled to 90 ft. hose length. During test phase, turbulence from open bomb-bay door was too severe for receiver aircraft and bomb-bay fairing was added. Provision has been made for de-icing probe before contact. Probe is spring-loaded for breakaway.

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lambda shock system upstream of the inlet.

A third shock in the system occurs ahead of the cowl lip, so that at supersonic flight speeds the diffuser is operating with flow spilling over the outside.

In spite of the apparent aerodynamic complexity of the system, the ram pressure recovery is high. During one flight test at Mach 1.8, pressure recovery readings at the face of the Atar inlet showed diffuser efficiencies of about 0.9 and for the bypass air showed efficiencies only slightly lower.

There have been no indications of flow instability in the ramjet system, such as would produce "buzz" at the inlet by alternately swallowing and regurgitating the shock.

So far Nord engineers have seen no need for modification of the present inlet configuration, although it has been increased in area once. It is possible that for the higher speed ranges, the increases in pressure loss caused by sticking to the simple pitot inlet may force a change to a more sophisticated type.

Diffuser efficiency curves plotted against Mach number generally stay high and flat for a small portion of the speed range, and then drop rapidly. The Griffon's inlet is obviously operating on the high portion of the curve now, but if the flight envelope is extended much further, it will start sliding down toward low efficiencies. For this reason, a central conical-form body may be necessary to generate a second inclined shock system and further reduce the approach Mach number so that the efficiency increases again.

Powerplant Tests

Before the Griffon flew under the thrust of its ramjet, the powerplant had been tested on the ground in tunnels in simulated flight.

The airframe, almost exactly as it exists today, was built in prototype form and powered solely by the Atar engine. That layout, the Griffon I, first flew Sept. 20, 1955. The major aim of the flight test program was to obtain data points on the aerodynamics of the configuration, uninfluenced by what were then the uncertainties of ramjet operation.

The powerplant of Griffon II was tested in a complete fuselage in the giant tunnel of ONERA, the French equivalent of NACA, at Modane. Ignition, shutdown and sustained operational conditions were produced in the tunnel for the turbojet and ramjet, and for both together. The success of these tests paved the way for the flight trials of the second phase of Griffon development.

Modified to take the complete powerplant, the first prototype Griffon I became the second prototype Griffon II

for flight tests. It made its first flight Jan. 23 last year.

First ramjet ignition was made on the 17th flight, using a pilot light to ignite the rest of the chamber. On March 15 during the 18th scheduled flight, the ramjet was ignited electrically in the usual way without the pilot light.

Two days later, the Griffon eased through Mach 1 on its 20th flight with Nord Chief Test Pilot Andre Turcat at the controls.

First phase of the flight test program ended June 6 and the airplane went into the shops for modification of the air intake. With a larger inlet fitted, the flight envelope was gradually extended until Mach 1.5 was reached. At that point there was a second brief halt while engineers and pilot took a good look at the results, because they wanted to avoid the phenomena that had made trouble for other planes at that speed.

Nothing showed in the test results to indicate any problems. Flights resumed and Turcat, in one test, rolled the airplane at Mach 1.6. The flight test program was to be terminated at Mach 1.85, primarily for reasons of heating on the engine, and that day came on Dec. 9 last year when Turcat rocketed upward in a climb at that speed. This marked the end of the first phase of the Griffon flight test program.

Only major change during the flight test work with the Griffon II was enlargement of the air intake; there were no configuration changes in the airplane except for canopy redesign and no control changes. Ventral fins, tried on the Griffon I, were not installed on the Griffon II. They may be needed in later flight test work as both altitudes and speeds are increased.

Observers expect that the next development phase of the Griffon will be to install the Snecma Super-Atar, the so-called "all-steel" engine designed for the Mach 2 or 3 regime. That engine is considerably larger than the Atar E.3 now in the Griffon, and would demand a much larger powerplant bay and air inlet. The Griffon configuration, with its cockpit divorced from the powerplant, will be relatively easy to modify to take the bigger engine.

Family Tree

There are some aerodynamic similarities between the Griffon in its present form and Nord's predecessor delta design 1402 "Gerfaut." Both have similar delta wings and swept vertical tails; both have straight-through powerplant systems. Consequently the flight test program of the Gerfaut contributed greatly to the background and experience of pilot Turcat and the engineers working on the projects.

The two planes differ in powerplant and in longitudinal control systems. The Gerfaut used a small slab delta-

A quiz for Rocket Propulsion Engineers

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3. What is the effect on turbine blade design of a working gas which is still reacting and changing its composition?

4. What are the dynamic interrelations among the various components of a rocket engine, and what control systems will best solve the rocket engine control problems?

5. What is the flame holding mechanism in a rocket motor and how can fundamental understanding of such a mechanism be used to increase reaction ratio?

6. What types of fluid transport systems offer simplicity, efficiency, and light weight (other than the conventional turbopump)?

7. What are some workable methods of translating chemical energy into thrust – other than by the standard combustion at high pressure and then conversion to velocity?

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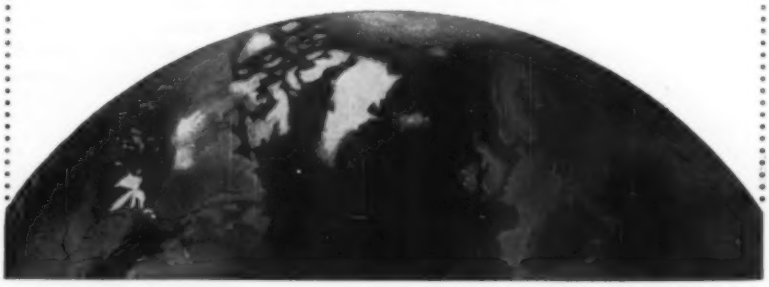

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tail with blunt trailing edge for pitch control; Griffon uses elevons.

Both planes had a common ancestor in a wooden glider developed originally as a low-speed test vehicle for the Arsenal 2301 interceptor. The glider, designated Arsenal 1301, was first designed with a swept wing and later equipped with delta surfaces of two different sizes. Its test program was aimed at getting low speed data for two variants of the Gerfaut: The Gerfaut 1A with 204 sq. ft. of wing area and the Gerfaut 1B with 282 sq. ft. of wing area.

Later the glider was fitted with the fixed nose surfaces that became the trademark of the Griffon; for some of its flight trails it retained its conventional horizontal tail as well.

To keep the history complete, the Griffon started life named "Guepard" (Cheetah); Griffon is, of course, a mythological figure which combines the best features of a lion and a fire-breathing flying dragon. "Gerfaut" means "Falcon" in English.

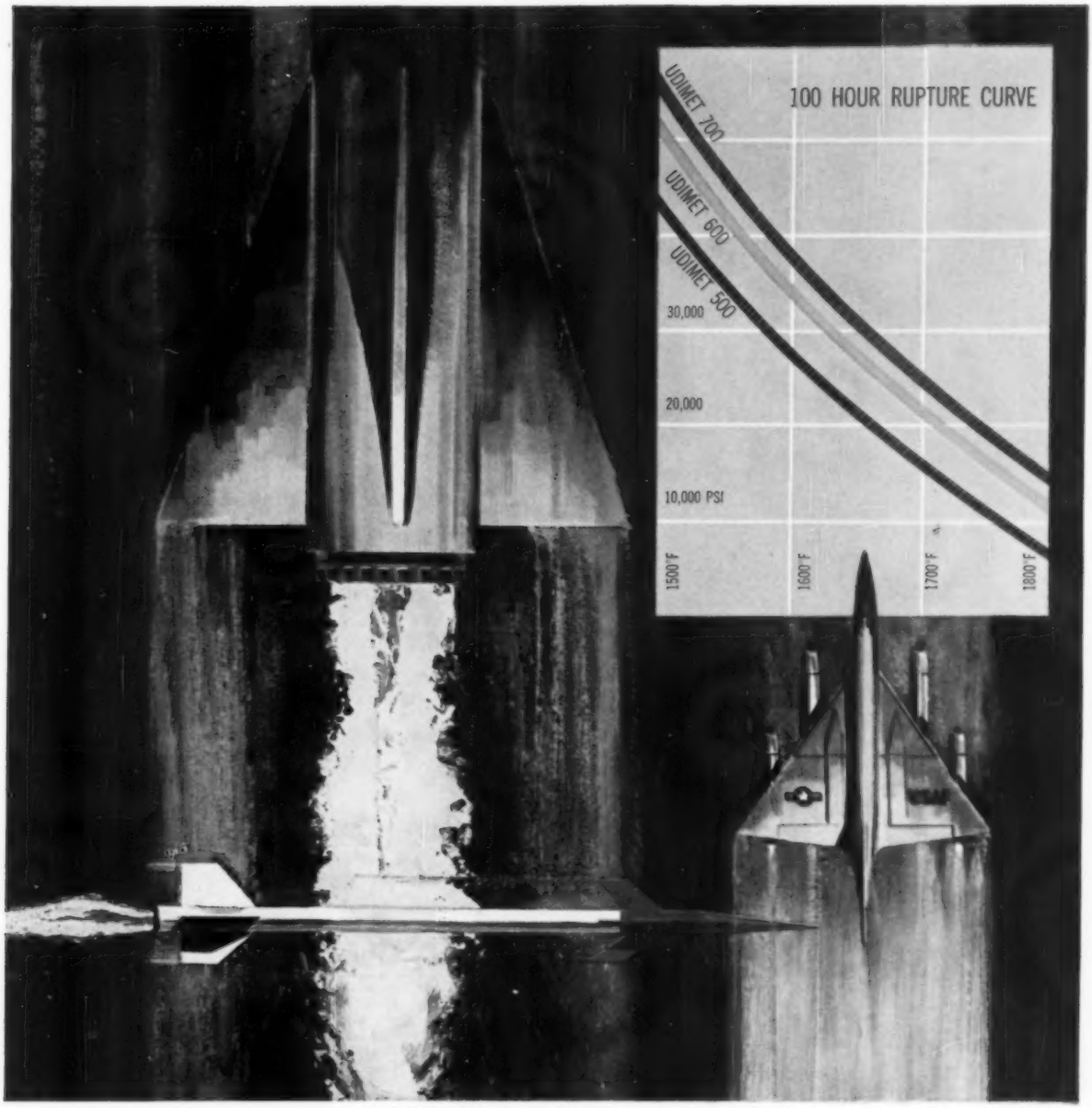
There were more than airplane name changes during the Griffon program. Nord-Aviation recently took that corporate name in place of the more unwieldly Societe Nationale de Constructions Aeronautiques du Nord (SNCAN). Before that, the former government organization Arsenal de l'Aeronautique had been absorbed by the Societe Francaise d'Etudes et de Constructions de Materiels Aeronautiques Speciaux (SFECMAS) which Nord took over in 1955.

Nord dates back to the nationalization of the French aircraft industry in 1936, when it was formed primarily from the Societe des Avions Henry Potez. In later years it absorbed others of the great names in French aviation: Caudron, Amiot, Hanriot.

Now it is the second largest aircraft factory in France, with about 8,000 technicians and workers. It has three major divisions: highspeed aircraft, which handles projects like the Gerfaut and the Griffon; missiles, which has developed the highly successful SS-10 anti-tank weapon recently ordered by the U. S. Army, and transport, which has designed and produced the Noratlas transport for the French and Germans.

X-15 Rocket Powerplant Test Stand Being Built

Reaction Motors, Inc., Denville, N. J., is building a 100,000 lb. thrust capability test stand to accelerate testing of Pioneer, rocket powerplant for X-15 research aircraft. Located at Lake Denmark, N. J., stand will be built for horizontal firings, but with a provision to accommodate all-altitude testing. Completion date for the $300,000 test unit is June 1, 1958.



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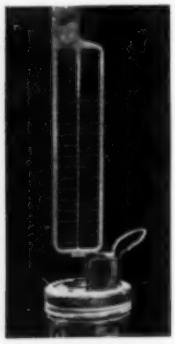

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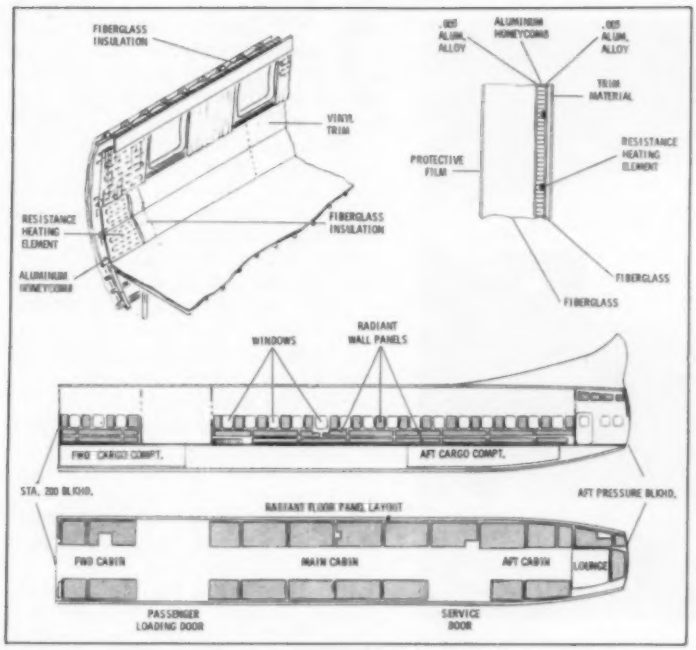


IN LOCKHEED method for imbedding resistance elements (wire) in Electra's cabin radiant-heat panels, insulated wire is placed on one face sheet for sandwich panel and honeycomb core is placed over wire (left). Roller imbeds element in core. Installation is depicted at right.

Electra Designed for Production Savings

This is the second of two articles by Irving Stone on the Lockheed Electra turboprop transport. The first article appeared in last week's AVIATION WEEK.

Burbank—Lockheed Aircraft Corp. has designed the Electra turboprop transport to stress levels considerably below the permissible ultimate tensile strength in wing, fuselage, empennage, landing gear and other parts of the aircraft.

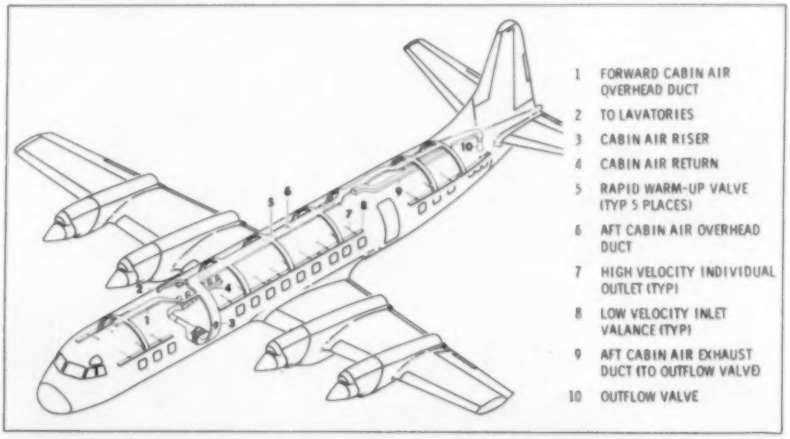
For example, in wing empennage, stress level is about ⅜ that of available strength. In fuselage, stress level due to pressurization is about ½ that of available strength. In landing gear critical areas, such as lugs, Lockheed is using only about half the available material unit strength.

Lockheed has cranked in an exceptional amount of pre-proving to ensure top reliability. More fatigue testing has been performed on Electra structure than on any previous Lockheed plane, including military articles. Extensive tests have been conducted on wing joints and surface discontinuities (changes in direction of primary structure and cutouts) to determine that these would not be a cause of fatigue failure. As a result of this extensive test phase, outer wing panel-to-center section joint was modified and changes were made in material distribution and detail radii.

Fatigue tests were conducted on Electra fuselage structure and on the very similar Constellation structure because these panels were available immediately. Under cyclic air pressure loading simulating Electra pressure, panels were tested without windows and with windows of various configuration, finally leading to development of forged window frame. Whereas cracks could be developed in the skin with extended testing, they stopped at the window frame, normally a critical area.

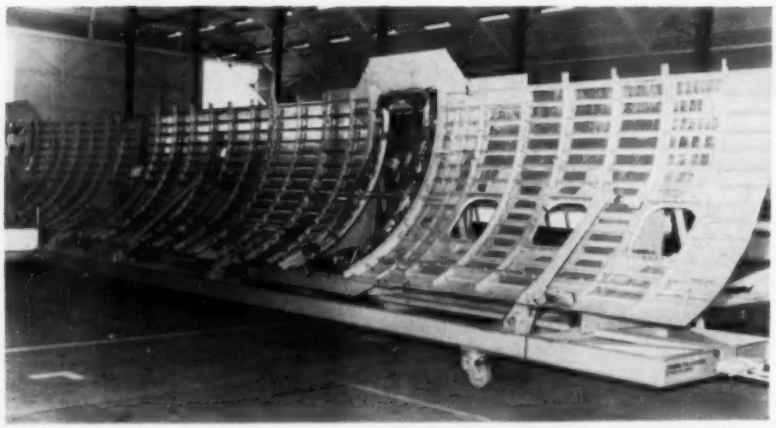
In addition to these panels, a complete Super Constellation barrel (similar to Electra in size, structural arrangement and detail components) was used to simulate forced vibration from propeller blade passage. Knowledge gained from this test was incorporated into Electra design, led to reinforcement in region of the propeller plane of both Electra and Super Constellation. Principal modification was increase in fuselage side radial stiffness by factor between two and four, depending upon specific area.

Fuselage joints were painstakingly checked and changes made. For example, the most critical joint from a tension viewpoint is in a girth direction at the top of fuselage above the


1 FORWARD CABIN AIR OVERHEAD DUCT
2 TO LAVATORIES
3 CABIN AIR RISER
4 CABIN AIR RETURN
5 RAPID WARM-UP VALVE (TYP 5 PLACES)
6 AFT CABIN AIR OVERHEAD DUCT
7 HIGH VELOCITY INDIVIDUAL OUTLET (TYP)
8 LOW VELOCITY INLET VALANCE (TYP)
9 AFT CABIN AIR EXHAUST DUCT (TO OUTFLOW VALVE)
10 OUTFLOW VALVE

CABIN air cycle system in the Electra can reduce cabin inlet temperature to as low as 55F.

PART OF Electra external engine skin is of flame-resistant, relatively non-buckling titanium.



FUSELAGE section is built in panels rather than in barrel sections for production economy.

CENTER wing section of the Electra has large forged fuselage frames at front and rear spars.

wing. Modifications in skin attachment and fittings were made in this area. Main and nose landing gear were exhaustively checked in fatigue trials. Loads were introduced to simulate actual landing, braking, engine runup and taxiing over reasonably rough runways. In all, about 50 different loadings were used to simulate the spectrum associated with one flight.

Main landing gear already has more than 220,000 simulated flights chalked up against it, with no major difficulties encountered. Nose gear has successfully been put through 160,000 simulated flights and results indicate extremely long structural life.

Other gear trials included drop tests to establish orifice sizes for landing impact absorption. Simple orifice plate was found to be satisfactory for main landing gear, while nose gear required use of a tapered metering pin in combination with the orifice plate.

Electra nose gear steering motor and shimmy damper are combined in a single unit. Early tests on complete nose gear in Lockheed's shimmy tower indicated steering difficulties stemming from too much friction in the system. Steering mechanism was redesigned to eliminate objectionable friction; design then was tested for shimmy and proved stable.

Fuselage Pressure Tests

In fail-safe fuselage tests, Lockheed engineers are inflating Electra body to operating pressure, applying bending loads which would stem from severe turbulence, then severing critical elements during this loading condition. This is the first time Lockheed has used an entire fuselage—from forward to aft pressure bulkhead—for this type of testing, to completely simulate severe operating conditions.

About 36 cuts are being put in critical areas. One of these locations is the heavy, forged main frame for fuselage-to-wing attachment, which will be severed completely. Other locations include window frames, windshield posts, fuselage skins and frames, and corners of doors.

Wing fail-safe tests have been completed, and original design essentially has been verified. Tests show that fail-safe requirements of shear webs, spar caps and integrally stiffened surface structure have been exceeded.

For fail-safe characteristics in the windshield, construction comprises an outer layer of $\frac{7}{16}$-in. Nesa-heated semi-tempered glass backed by $\frac{1}{4}$-in. vinyl, followed by $\frac{1}{4}$-in. full-tempered glass main pane, and inner pane of $\frac{7}{16}$-in. glass separated from main pane by $\frac{1}{4}$-in. vinyl. During tests, all glass panels were deliberately failed and it was shown that vinyl alone was sufficient to

carry up to twice cabin operating pressure. Bird impact test results dictated use of the ⅛-in. vinyl and ¼-in. glass to contain any broken pieces of main pane, preventing them from striking the pilot. Without these inner vinyl-glass layers, flying particles of main pane mutilated simulated pilot (clay dummy).

Fuselage cabin windows incorporate biaxially-stretched Plexiglas 55 in two panes—.35-in. outer sheet and .25-in. inner sheet. Outer pane normally carries cabin pressure. In fail-safe demonstration, outer pane was deliberately failed under twice the cabin operating pressure and inner pane withstood the load although it had been previously scored and punctured to simulate possible service abuse.

Ducting for distribution of engine bleed air for anti-icing wing and empennage leading edges was designed as a tension system with only four mechanically flexible joints in the primary lines—one at each engine near its bleed port manifold. Since dimensional changes in the system due to thermal expansion, wing flexure and engine motion must be taken by flexing, high strength stainless steel alloys were used for the distribution lines.

Complete mockup of the system was operated under simulated icing conditions to verify structural integrity. In addition, the portion of the system at the engine was fatigue-tested successfully at maximum temperatures and pressures by cyclicly varying engine motions.

Thermal Mockup

Elaborate full-scale thermal mockup is being used to check and refine air conditioning (heating and cooling) installation. Costing about $120,000, this specially-constructed unit represents a 40-ft.-long section of the Electra fuselage completely trimmed on the inside including cabin liners, insulation, carpeting and lights. Hot or cold fluids are circulated through metal tubing on the outside of the skin panels to produce temperature ranges for various time periods in simulated flights. Mockup is instrumented on inside to record corresponding conditions in cabin. Tests during the past year have proven system performance and have resulted in improvements over original specifications.

To determine acoustic characteristics of the bare fuselage and the fuselage with insulation and interior trim, Lockheed constructed a mockup fuselage section about 25 ft. long, costing about $100,000. Tests are being run with noise source spanning a spectrum from about 50 cps. to about 4,000 cps. Effects of frequencies above 4,000 cps. can be readily projected. Under these conditions, various types of acoustic treatments have been checked. Results have given an optimum distribution for weight of Fiberglas used in cabin insulation. Also, it has been found that use of isolated radiant heat panels provide in some degree the effect of using a double-wall structure. Insulation, tape and trim have been firmed, but tests are being continued to achieve possible improvements for future Electras.

In addition to the program on the acoustic mockup with external noise source, hydraulic mockup also has been used to determine sound levels resulting from operation of pumps and lines underneath fuselage floor. This has resulted in development of pump box enclosures, pump vibration mounts and acoustic filters for hydraulic lines.

Tests indicate that Electra, with its 15,000 eshp. for takeoff and 13.5-ft.-diameter four-bladed props, will be appreciably quieter than a 1049G Super Constellation with 13,600 bhp. and 15.2-ft. three-bladed props.

First flight-test Electra is not completely trimmed, but sound measurements indicate that target levels will be met.

In engine supporting structure, stainless steel is used where operating temperature and fire barrier requirements must be met. Titanium is used for ex-

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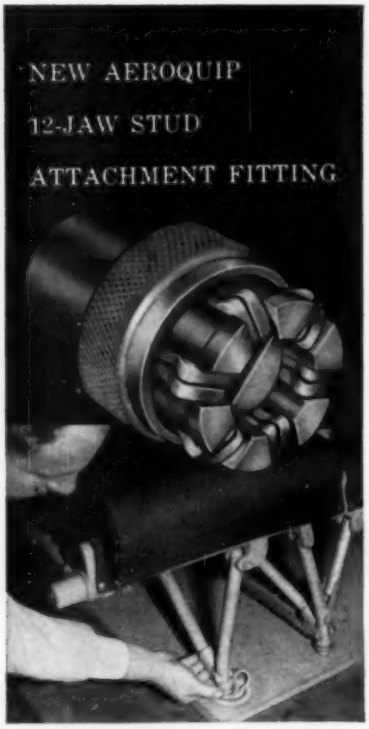

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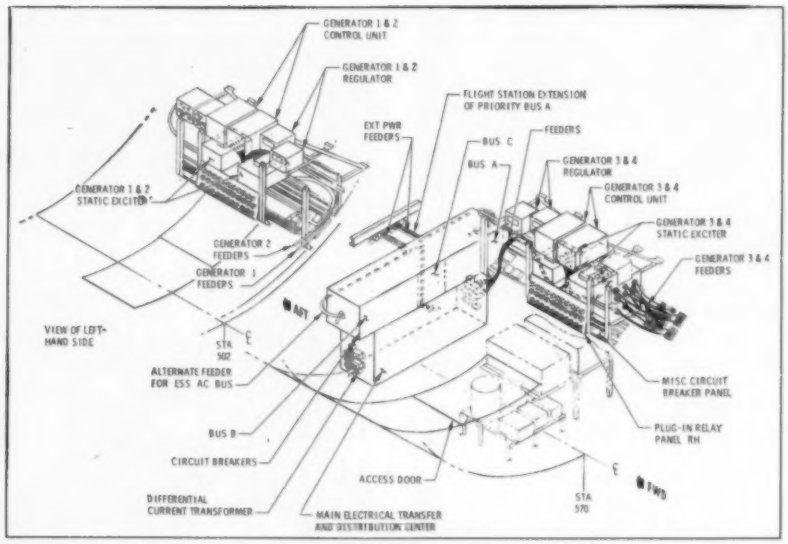

ELECTRA electrical service center is located in fuselage bottom. Artist's drawing demonstrates equipment concentration designed for easy access and maintenance.

ternal skins for flame resistance and structural efficiency from non-buckling standpoint when compared with thinner sheets of stainless steel of same area weight. Aluminum alloys are used for sub-structural elements where temperature conditions permit. Complete supporting structure has been static-tested from forward engine mounts aft through wing attachments, with successful results through six ultimate loading conditions.

No radical structural features have been introduced in the Electra to attain speed of more than 400 mph. Emphasis has been placed on simplifying the structure to achieve weight and manufacturing economies wherever possible. Highlights of Electra structure are:

• **Integral stiffening,** large single-piece forgings and chemical milling have been used for design, production efficiencies.

• **Fuselage skin is 2024** aluminum alloy supported by 7075 aluminum alloy C-rings. Heavy extruded 7075 ring frames are employed at cutout areas such as cabin doors and other access openings. Chemically milled doublers are used to surround openings, serving as additional load path to prevent cracks from progressing into basic shell. Heavy 7075 forged frames connect fuselage to front and rear center-section wing beams.

• **Windshield framing rigidity** has been insured by use of heavy extruded 7075 posts and heavy 7075 sheet metal sills. Posts and sills incorporate multiple-piece makeup for safety.

Two large 7075 truss-type forgings do double duty by supporting cockpit floor and nose gear.

• **Wing upper and lower surfaces,** made up of nine spanwise panels at the root and narrowing to three at wingtip, are machined from integrally stiffened extrusions 17 in. wide. This panel width was established by fail-safe requirements to ensure that failure of one panel would not induce failure into adjacent panels. Panels are machined to taper skin, stiffener height, and stiffener thickness for weight saving. Lower skin is 7075 aluminum alloy, upper skin is 7078 for better compressive strength. Front and rear spar webs are machined from 7075 plate tapered in thickness from root to tip. Web stiffeners are extruded 7075 bulb T-sections, designed to pick up shear load from a failed web and transfer it to beam caps.

• **Entire outer wing panel** comprises two fuel tanks, with inboard tank ex-

Electra Timetable

As of middle of March, Electras have achieved 99 flights totaling 145 hours, as follows:

Electra No. 1, 106 hr. in 75 flights.
Electra No. 2, 39 hr. in 24 flights.
Third plane will fly April 10; fourth is scheduled to fly in May.

Electra orders total 144:

American Airlines	35
Eastern Air Lines	40
National Air Lines	23
KLM	12
Braniff Airways	9
Western Air Lines	9
Garuda Indonesian	3
Cathay Pacific	2
Pacific Southwest	3
Ansett/Ana	4
Aeronaves de Mexico	3
General Motors Corp.	1

tending from fuselage to inboard engine nacelle, outboard tank extending from outboard of inboard nacelle to wingtip.

• **Outer wing panel-to-center** section joint is combination shear and tension type. Upper and lower wing surfaces and front and rear spar webs are connected with shear type splice plates. Spar caps of the two wing sections are connected with 7075 forged tension bathtub fittings.

Production Economies

Lockheed is streamlining its production to introduce new manufacturing economies for the Electra.

Scheduled to be put into operation this June at an installed cost exceeding $700,000 is a numerically controlled Kearney & Trecker skin mill, which will cut manufacturing costs, improve repetitive quality. Machine bed will measure 12 x 52 ft., probably will process two integrally-stiffened extruded skin panels simultaneously.

To facilitate movement along production line, Lockheed has devised a massive gate-type jig constructed of 18-in. oil well casing, which swings open to permit passage of fuselage from the mating dock to the pressure dock, where structure is pressure-tested above operating value. Use of the gated jig eliminates large investment in overhead handling facilities, permits use of comparatively low headroom area.

For better pressure seal in entire cabin, sealant is applied between faying surfaces of skin laps and between skin and bulkheads and stringers, before riveting. This ensures complete distribution of sealant at possible leak points. Lockheed has found that injection of sealant after structural joint has been made does not permit as thorough a sealant job as does its practice on the Electra.

To reduce time for attachment of ribs to stiffener elements of integrally stiffened wing skins, Lockheed has devised a special multiple-head drill which puts four holes simultaneously in the stiffeners and in the H-clips located between stiffeners. A similar drill puts four holes in the H-clip web for attachment to rib tab.

Lockheed has developed a method for imbedding resistance elements (wire) in cabin radiant-heat panels. Insulated wire is placed on one face sheet for a sandwich panel, and honeycomb core is placed over wire. Roller, with preset depressing force, is passed over core, imbedding element in core. Core cells are filled with syntactic foam edging for about ¾ in. back. Other face sheet is added, and sandwich panel is cured in special heated fixture, using vacuum.

Compared to 1049G Super Constellation and 1649A Starliner, Electra has about three times as many plastic parts, producing considerable weight savings plus comparatively small tooling cost to make intricate shapes. Air conditioning ducts are almost exclusively plastic and, in addition to weight saving here, noise absorption is improved.

Allison 501-D13 turbojet embodies 14-stage compressor, six combustion chambers and four-stage turbine, with turbine shaft speed constant at 13,820 rpm. for all flight regimes. Compressor handles more than 30 lb. of air per second at compression ratio exceeding nine to one at rated sea level power. Compressor bleed air is used for aircraft anti-icing system, anti-icing of air intake scoops and successive engine starting.

Reduction gear cuts power section shaft speed of 13,820 rpm. to rated propeller operating speed of 1,020 rpm. In ground idle condition, 10,000-rpm. engine speed is reduced to 740 rpm. prop speed, cutting noise level during ground operations.

Aeroproducts propeller is four-blade unit incorporating spinner, manual and auto-feathering, and reversing action. Prop blade is hollow steel, has maximum blade width of 18½ in. Prop diameter is 13½ ft.

Prop spinner has electrical anti-icing system, maintaining wet running surface for critical areas. Cyclic de-icing removes ice from spinner blade islands and blade cuffs. Opposite blades are de-iced together for 12 sec. "on" and 84 sec. "off."

SPECIAL DRILL designed by Lockheed locates and drills four holes in H-clip and integral stiffeners of Electra skin panels. Device saves considerable time.

Propeller has its own oil supply, insuring hydraulic control in emergency if engine oil should be depleted rapidly.

Safety coupling automatically disengages reduction gear from engine in event of failure of power unit when

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1,500 shp. negative torque is reached. Coupling will operate only if serious power section failure, including negative torque system failure occurs.

Fuel control meters fuel going to temperature datum valve by sensing and correcting for air inlet pressure and temperature and power lever control position set by pilot.

Temperature datum valve bypasses portion of fuel received from fuel control. Amount bypassed depends on its density and turbine inlet temperature.

Amplifier electronically matches actual inlet turbine temperature with values selected by pilot. Resulting signal goes to temperature datum valve for positioning this valve accordingly.

For cabin cooling, air cycle system can reduce cabin inlet temperature to as low as 55F. When additional cooling is required because of high ambient temperature, such as on the ground, Freon vapor cycle system operates automatically to maintain comfortable cabin temperatures and humidities. Flight station has air conditioning system separate from main cabin system. Cockpit has Freon evaporator, recirculating fan and electric heating element.

Cabin pressure is supplied by two compressors geared to inboard engines, with air supply taken from engine main air inlets. Compressor systems are designed for parallel operation but can operate independently. System can maintain cabin at pressure equivalent to 8,000 ft. during operation up to 30,000 ft., and at sea level cabin altitude up to 15,500 ft., with either one or two compressors.

Electrical system incorporates three direct-driven and one gearbox-driven 60-kva., 400-cycle a.c. generators, one on each engine. Each generator supplies power through a three-bus system. In case of failure, loads are switched to remaining generators. Emergency power is from battery or inverter.

Direct current power is obtained with two 150-amp. transformer-rectifier units providing 28 volts. Each unit can handle all d.c. loads.

Electra fuel system incorporates two integral tanks in box beam of each wing, independent accessories and plumbing for each engine, crossfeed system, single point underwing pressure fueling provision as well as conventional over-wing fueling arrangement. Inboard wing tank holds 1,090 gal., outboard tank holds 1,590 gal. Expansion space is equivalent to at least 2% of tank gross volume. Each of the four wing tanks feeds fuel to one engine, with all tanks connected to a crossfeed manifold for feeding fuel from any tank to any engine.

Single point underwing fueling is centered in No. 3 engine nacelle. Flow to any tank may be shut off in fueling, or tank float valves automatically will reduce fueling rate at 90% tank capacity and shut off at full capacity.

Dump chute, equipped with flame arrester, is provided on each side of the aircraft to serve the two tanks in each wing. Dump system uses pressure fueling manifold, hence is automatically tested for leaks each time underwing fueling system is used.

Passenger oxygen system is constant-flow type, includes 38.4-cu. ft., 1,800-psi. storage cylinder, continuous-reading cylinder pressure gages in cabin and at cylinder location, regulators, etc. Portable oxygen cylinder (11 cu. ft.) with both demand and constant flow outlets is located in cabin for emergency use. Crew oxygen system is separate, hooks to 38.4-cu. ft., 1,800-psi. storage cylinder, has four dilutor-demand regulators. Flight station also has 11-cu. ft. portable oxygen cylinder.

Aileron, elevator and rudder control systems incorporate cable installations to booster, and push-pull rods to control surfaces. Boosters give pilot definite control feel. Each booster includes emergency bypass mechanism.

Speed brake flaps normally operate through same range and in conjunction with wing flaps by means of automatic control interlock which functions when wing flap is operated.

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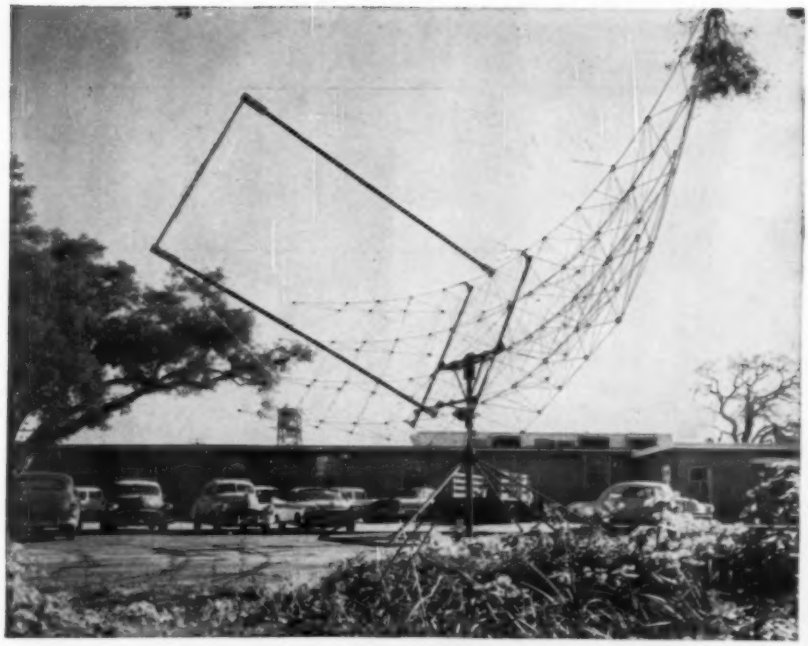
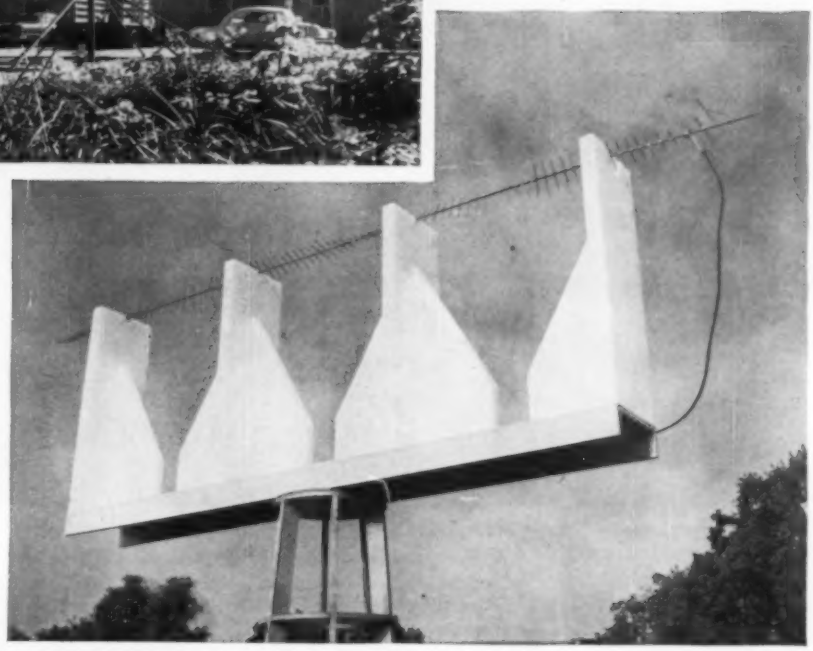
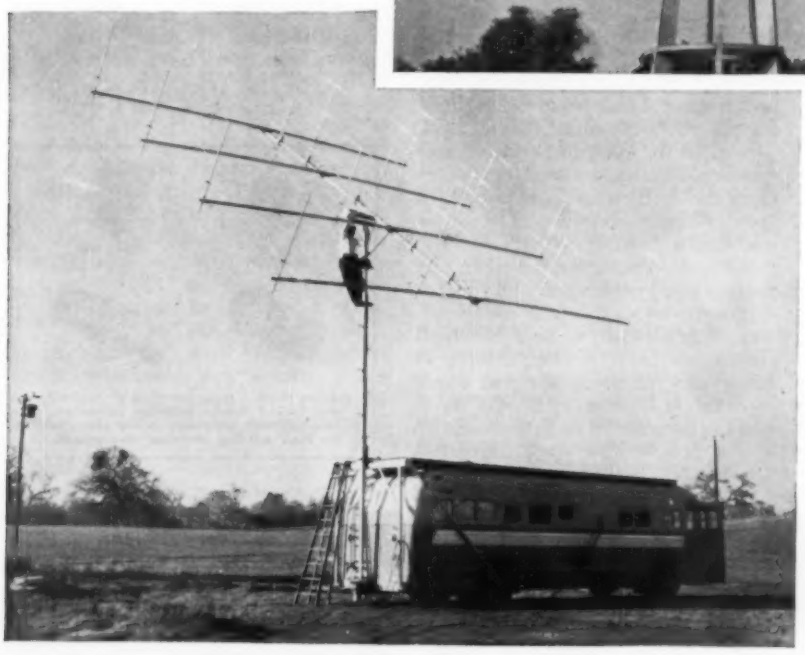
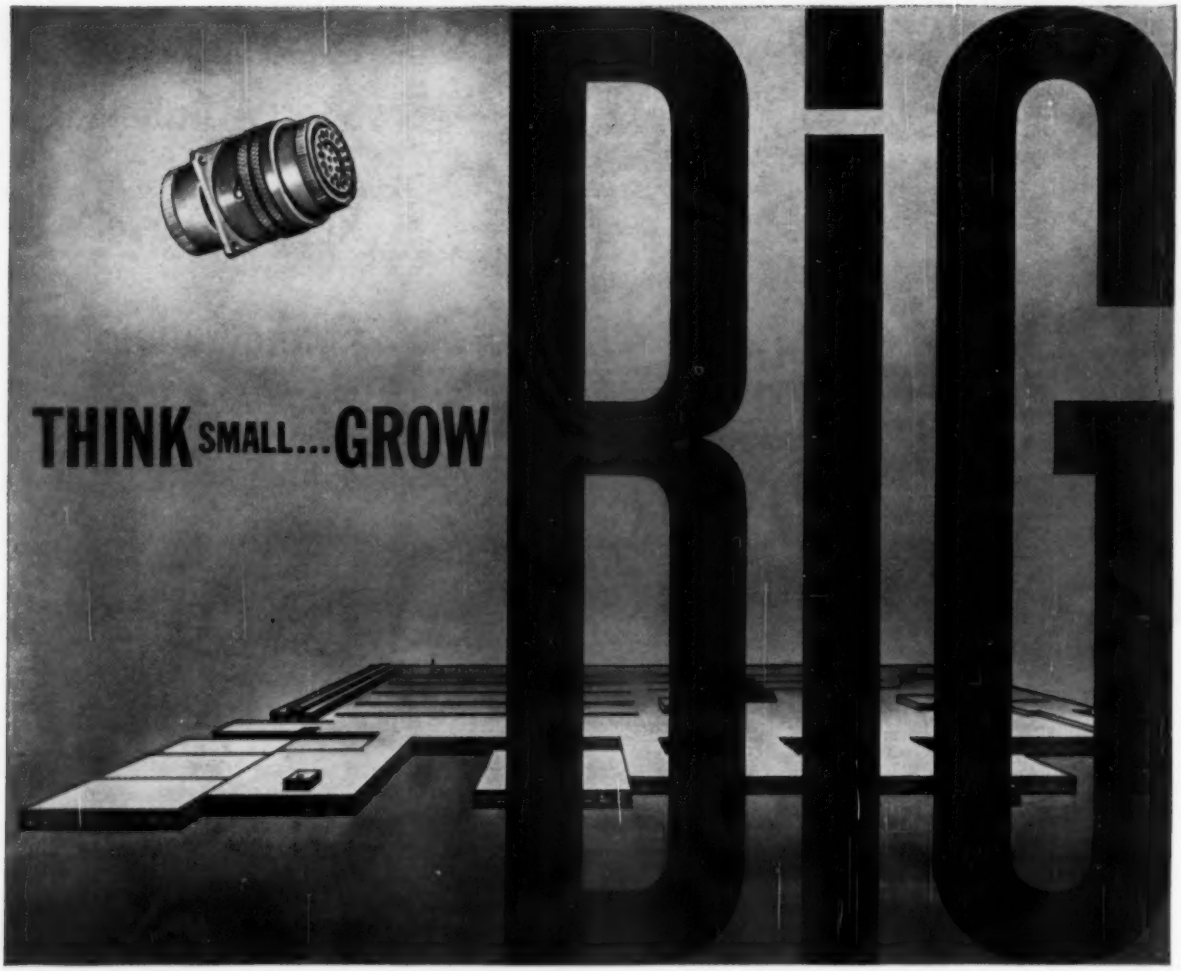




Fathered by the straight wire aerial, special purpose antennas have developed into strange and curious shapes. Parabolic segment antenna (top) is in use in Alaska to receive 400 mc. signals probing the aurora from transmitter 50 mi. away. Broadside yagi array (bottom) is used similarly by Stanford Research Institute to study 100 mc. signals reflected by the moon and meteor trails.



Designed to provide more sensitive antennas in the VHF-UHF range, the twist antenna (above) is an improvement of the common parallel rod yagi. Extension beyond normal yagi length is possible because the cross rods twist in a spiral about the axis. Spiral configuration above is 10 ft. long but can be used to many times this length with corresponding increases in antenna gain. One advantage of this type of antenna is that it can be used in many installations normally requiring expensive and cumbersome paraboloid antennas. Test antenna shown is supported on styrofoam.



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AMB Outlines Bid Award Method As Aid in 10 Procurement Plans

By Philip J. Klass

Washington—Airways Modernization Board has revealed details of the procedure it will use in picking winning contractors for its major developments and which was used to select General Precision Laboratory over 17 competitors to develop AMB's new automatic data processing system. Information is expected to be helpful to companies planning to bid on 10 other major procurements which AMB plans for this year.

Agency's technique of using quantitative rating by separate groups of experts is an adaptation of proposal evaluation procedures used in major Defense Department procurements. Procedure was worked out by Col. Carl Fisher, AMB project manager on the data processing program and chairman of the evaluation team.

AMB decided in advance to evaluate data processing system proposals on the basis of three major factors:

- **Operational concepts.**
- **Technical excellence.**
- **Company background,** including key people who would work on the program.

Contractors were asked to submit their proposals in three separate binders, each corresponding to one of the three areas to be evaluated. Those proposals dealing with operations were reviewed only by the operations evaluation group, while the technical group received only the technical proposals.

Each evaluation group, consisting of six men, was headed by an AMB expert. Majority of the team members were selected from men recommended for the job by the three military services and the Civil Aeronautics Administration, in response to an AMB request.

Group that made the operational evaluation, for example, was headed by a former CAA traffic controller on leave from the Air Transport Assn. Two others were CAA traffic controllers on temporary duty with AMB. Remaining three members were military pilots (two Air Force, one Navy), two of whom also have traffic control experience.

Evaluation procedure prepared by Fisher called for a preliminary elimination in event that more than 18 industry proposals were received. Although only 14 came in, five of the 14 were dropped after initial study because one or more of the evaluation groups unanimously agreed they were inadequate and failed to meet the agency's requirements.

Proposal of each bidder is simultaneously studied by all members of an evaluation group, and a decision is made to reject or pass it, before proceeding to the next company's proposal. Decision to reject a proposal during initial phase requires evaluation group to write a statement giving reasons for its decision.

Proposals that get past first hurdle are then restudied individually by members of each evaluation group, rated "excellent," "average" or "poor" by each member of the group according to a number of criteria on a formal rating sheet.

For example, operational evaluation of the recent data processing proposals was based on the following criteria:

- **Understanding of operational** problem.
- **Meeting user requirements,** with separate ratings for military, general aviation and commercial airlines.
- **Safety relative** to present system.
- **Ease of exercising** control.
- **Capacity relative** to present system.
- **Traffic rate relative** to present system.
- **Efficiency of airspace** use.
- **Ease of transition** from present system.
- **Extent of coordination** with air defense.

Technical Evaluation

The six-man technical evaluation group prepared rating sheets which called for similar appraisal of the following factors:

- **Understanding of problem.**
- **Technical feasibility** of proposed solution.
- **Completeness of engineering** proposal.
- **Effect of component** failure (on system operation).
- **Reliability.**
- **Expandability.**
- **Fail-safety.**
- **Ease of maintenance.**
- **Man-machine relationship.**
- **Time schedule.**
- **Feasibility of test plan.**
- **Amount of design required.**
- **Amount of fabrication** required.
- **Availability of** GFE equipment required.

Third AMB evaluation group members each had two rating sheets, one intended to appraise the corporate experience and facilities in the data processing field, the other to evaluate the

But the Navy's WV-2 picket planes turn this particular corner of the ocean *every time.* It's Long. 60°15′ E, Lat. 35°47′ N. These long-ranging patrol craft don't need sign posts or markers to stay precisely on assigned routes.

Servo Corporation's DEAD RECKONING TRACER (DRT) — aboard *every* Super Constellation that flies AEW patrol—traces out on a Mercator chart a permanent record of the plane's flight path. The DRT continuously provides a corrected and accurate display of the plane's present position. While this information is being traced out on the chart automatically and simultaneously, the exact figures of longitude and latitude are displayed on the computer counter as well as remote indicators.

Servo Corporation developed the Dead Reckoning Tracer in 1955; it went into service in 1956. The Navy has rated the Servo DRT *"the most accurate automatic system developed anywhere in the world to date."*

Because of the outstanding performance of the patrol DRT installations, Servo Corporation is now developing a smaller, lighter-weight model for fighter planes — under Air Force contract designation AN/APA-110 DRT.

For information on other advanced navigational aids and systems developed by Servo, call or write:

SERVO CORPORATION of AMERICA

20-20 Jericho Turnpike, New Hyde Park, L.I., N.Y.

A report to engineers and scientists from Lockheed Missile Systems—
where expanding missile programs insure more promising careers

COMPUTER "FLIES" MISSILE DESIGNS, SPEEDS POLARIS DEVELOPMENT

A new analog computer is today speeding early development of the Polaris ballistic missile by virtually "flying" missile designs right off the drawing board.

These "test flights" eliminate design flaws and come up with a workable form without wasting time and money building and flying proposed missile shapes.

Two Univac Scientifics are also included in the division's computer facilities — already among the most extensive in the west.

Advanced facilities like our computer installation have been developed through expansion in a variety of missile programs. These missile projects—including Polaris, X-7 and Q-5—have earned Lockheed leadership in missile technology.

More advanced projects we cannot talk about are under way. This means engineers and scientists who join Lockheed Missile Systems now, can enjoy opportunities to grow rapidly in the years ahead.

Positions are open for qualified people in: **Information Processing, Telecommunications, Reliability-Producibility, Ground Support, Guidance, Flight Controls, Aerodynamics, Thermodynamics.**

Write or send résumé to M. W. Peterson, Research and Development Staff, Sunnyvale 31, California.

Lockheed **MISSILE SYSTEMS**

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ • CALIFORNIA

Group leader Robert Turner, right, discusses results of a problem with Math Analyst Richard Hayes.

similar skills of individuals whom the company proposed to assign to the project. Experience or talent factors listed on the corporate rating sheet and duplicated except for facilities and delivery record on the individual talent sheet, included:

- **Data processing.**
- **Display.**
- **System work.**
- **Fabrication.**
- **Field engineering.**
- **Simulation.**
- **Flight test.**
- **Traffic control work.**
- **Knowledge of New York area.**
- **Fabrication facilities** (corporate).
- **Test facilities** (corporate).
- **Record of on-time deliveries** on government contracts.

When each member had finished rating all proposals, he placed the rating sheet in an envelope without disclosing scores to other group members. Envelopes were sealed, collected by group chief, delivered to evaluation team chairman Fisher unopened.

Weighting Factors

Recognizing that an "excellent" rating for certain evaluation criteria should carry greater weight in the overall score than the same rating for another criteria, AMB set up a point-weighting system which was shown on the rating sheets. For example, an "excellent" rating on company experience in data processing might be worth "X" points, while an "excellent" rating in flight simulation might be worth only "X/2" points. As might be expected, company's record for on-time deliveries rated a high weighting factor because of AMB's short program timetable. (AMB declines to release specific weighting factors used).

In arriving at a composite score for each company's total proposal, a formula was employed which gave equal weight to company's sub-total score for each of the three major evaluation areas i.e.: operations, technical and company background. However, once this had been done each company's composite score was determined by multiplying – not adding – the weighted scores it had received for the three individual portions of its proposal.

This method of combination was intended to prevent a company with a very low score in one of the three areas, but high scores in the other two, from walking off with the competition. For example, a company's technical proposal and operational concept might be excellent, but if it had an extremely bad record of late deliveries on previous government contracts, chances were that it would not meet the critical timetable which AMB has set for the program. (AMB team had access to

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For extremely sensitive instrument applications where minimum torque is essential, specify Giannini Microtorque and Minitorque precision potentiometers. Highly reliable performance under the most rugged operating conditions is assured by Giannini's care for detail and production crafting.

By using sapphire jewel bearings... and precision ball bearings in certain Minitorque models, these 1 inch diameter instruments effect an unusually low coefficient of friction.

Available in 12 standard linear wiring types, the potentiometer output can, on special order, be designed to perform to a wide range of natural or empirical functions. All models employ non-corrosive precious metal windings and contacts... thereby permitting light brush pressures and ensuring long noise-free life.

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SPECIFICATIONS:

Torque	0.003 to 0.008 oz. in. depending on resistance and wiring type. (Sleeve bushing Minitorque 0.025 oz. in.)
Resistance Range	100 to 100,000 ohms.
Linearity	±0.5% (±0.25% on special order)
Power Rating	1.63 watts @ 25°C.
Shaft Diameter	Microtorque, 0.031 in., Minitorque, 0.125 in.

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Defense Department records on corporate delivery performance).

Only after the composite corporate scores are determined, and compared, does price come up for consideration. If the top scorer's price is comparable to the second-place bidder, the award goes to the high-ranking proposal. If two top companies have nearly identical scores on their proposals, then price can be the determining factor. The important thing is that none of the experts who evaluate the proposals are exposed to price considerations during their evaluation.

Specific criteria which will be used in rating each of the upcoming AMB procurements naturally will differ somewhat from those employed in the data processing system competition. However, Airways Modernization Board plans to employ the same scientific approach to weighing objectively all significant factors in selecting the winning bidder.

FILTER CENTER

▶ **Airline Flight Recorder**—Aeronautical Radio Inc. will hold airline-industry meeting April 9-11 in Washington to draw up specifications for an airborne flight recorder capable of meeting airline operational needs as well as new Civil Aeronautics Board regulation calling for use of recorders on all aircraft operating above 25,000 ft., effective July 15. Manufacturers interested in attending should contact William Carnes, Arinc, 1700 "K" St. NW., Washington.

▶ **All's Well SelCal**—Aeronautical Radio's Airline Electronic Engineering Committee has worked out details of a modified version of SelCal selective calling system which will permit ground station to interrogate any en route airplane and get an automatic "All's Well" reply without any pilot action. Original SelCal and All's Well modification, pioneered by Pan American Airways, required assignment of reciprocal code for the latter which made industry-wide code assignment more difficult. Technique evolved by Arinc's AEEC for getting around this problem involves addition of another set of tone replies in the 1,800 to 3,000 cps. band.

▶ **Wedding's Off**—Litton Industries and Aircraft Radio Corp. have called off plans to merge, following failure of sufficient number of ARC stockholders to put up stock for exchange for Litton stock. Earlier proposed merger between Airborne Instruments Laboratory and Aircraft Radio Corp. failed to materialize for similar reasons.

Key Openings for Electronics Engineers

Electronics activities are broad and fast-growing at Chance Vought. Projects involve advanced guidance and control and fire control systems for missiles and high-performance manned aircraft. They begin with investigations and theory and progress through systemization and packaging to detailed hardware design. Key responsibilities await additional men who are qualified in these areas. Advanced degrees are preferred.

Stability and Control Engineer. E.E., M.E., or A.E. with emphasis on flight stability and control problems or dynamics. (Special consideration given graduate study or extensive experience in transients or closed loop stability analysis.) To assist in design of autopilot and control systems for high-performance missiles and aircraft.

Antenna Design Engineer. E.E. or Physics Degree with demonstrated aptitude for antenna design. To join active projects involving design of flush-mounted, recessed and external antennas at all frequencies for very high-performance aircraft and missiles.

Fire Control and Microwave Systems Engineer. Requires E.E. or Physics Degree; at least 2 years experience in radar, data link, or fire control systems; and strong ability in this work.

Test Equipment Engineer. Requires E.E. or Physics Degree and at least 2 years experience in this or related field. (Desirable: broad background in electronics design with emphasis on digital computers or microwave systems.) To join in the design of complete checkout systems for missiles and associated subsystems.

Guidance Design Engineer. E. E. or Physics Degree, plus 2 or more years experience. To design various active and self-contained missile guidance systems, and to design and develop radar beacons.

Reliability Analyst. Requires M.E., Physics, E.E., or Math Degree; broad knowledge of electronic and mechanical systems; experience in operations research or reliability. Helpful: statistical methods experience.

Electronic Packaging Engineer. M.E., E.E., or equivalent packaging design experience. To help design ground, airborne and shipboard electronic equipment for use in severe environments. Involves consideration of heat transfer, shock, vibration and other factors.

To arrange for a personal interview, or for more information on these or other current openings, return coupon to:

C. A. Besio
Supervisor, Engineering Personnel
CHANCE VOUGHT AIRCRAFT, Dept. M-5
Dallas, Texas

I am a _____ Engineer,
interested in the opening for _____
Name _____
Address _____
City _____ State _____

Vought Vocabulary

re·lent′less: *a missile that pierces hostile sky to pinpoint its nuclear strike*

When a target's latitude and longitude are marked on this missile's brain, an appointment has been made.

To keep its rendezvous, the Chance Vought *Regulus II* performs miracles of navigation: it will launch stealthily from submarines – nuclear and conventional – from surface craft and mobile shore launchers. It will compensate automatically for wind and weather and for the earth's rotation. It will detour enemy strongpoints, outfox known counterweapons. Closing in on its quarry, it can plummet from over 60,000 feet to smokestack height to escape radar detection.

In minutes, *Regulus II* can pierce over 1,000 miles of hostile sky to score a nuclear bull's-eye.

The first of the Navy's nuclear-driven subs, designed to roam the seas as unseen *Regulus II* bases, is now in construction. The missile itself has made over 25 successful flights. Under Navy leash in key locations, it will be a relentless watchdog for peace.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. M-5.

CHANCE VOUGHT AIRCRAFT
INCORPORATED DALLAS, TEXAS

The Year Advertising Helped

This editorial message was first published by McGraw-Hill two years ago. It describes advertising's dramatic contribution to the American economy during 1954. The theme of the editorial—that advertising can help promote economic stability by stimulating sales at a crucial time—is even more pertinent today.

As our economy grows, it is constantly changing. The conditions business faces today are not the same in every respect as those it faced in 1954. But business again has the opportunity, through advertising and other selling efforts, to help sustain a high level of economic activity. At the same time, it will be building markets for the period of renewed expansion that is sure to follow.

This editorial is reprinted exactly as it appeared in 1956 except for minor editorial changes to bring it up to date. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGraw-Hill Publishing Company, Inc.

IN 1954 we had a business recession in the United States. Sales fell about 4% during the year. If management had followed the historic pattern of business ups and downs, advertising volume would have fallen much further.

But in 1954 the volume of advertising did not fall. It increased over 5%, and expenditures in all major advertising media rose. Every effort was made to stimulate sales when sales were needed to sustain prosperity.

This was something entirely new under the sun. It had a powerful influence in making the recession of 1953-54 one of the mildest on record. It helped greatly to speed business on to the record-breaking levels it attained in the years 1955-57.

There are several reasons why America's business management attacked this decline in sales with more advertising. One of them grew out of the greatly strengthened position of the American consuming market. Consumers' income after taxes has been rising an average of over $10 billion a year since 1946, and this rising income is more widely distributed than ever before. Furthermore, consumers had piled up reserves of about $200 billion in cash or its equivalent. These reserves offered a new and powerful inducement to increased selling and advertising effort even in the face of a possible decline in consumer income. (At the end of 1957, consumer reserves were $225 billion.)

Taking the Longer View

However, the principal reason why a sales decline was attacked with increased advertising is management's new-found conviction that good advertising is essentially an investment in the development of a market. Successful development requires sustained investment. The inclination of business management to take this longer view is, of course, motivated

McGraw-Hill PUBLISHING COMPANY,

ABP HEADQUARTERS FOR

Kill a Business Recession

by the fact that the American market, with over 3 million consumers being added annually, is growing at a prodigious rate.

Ten years ago only a handful of companies had plans for investment in new producing facilities extending beyond the current year. Today almost all leading companies have investment programs running some years ahead. And keeping pace with these long-range investment plans has been the development of sales and advertising programs to reach tomorrow's greatly expanded markets.

Advertising's Key Role

This crucial role of advertising in providing driving power for our economy is gaining greater recognition every day. In his book, "People of Plenty," Professor David M. Potter of Yale University remarked: "Advertising is not badly needed in an economy of scarcity, because total demand is usually equal to or in excess of total supply, and every producer can normally sell as much as he produces. It is when potential supply outstrips demand—that is, when abundance prevails—that advertising begins to fulfill a really essential economic function."

Today abundance so completely prevails in the United States that it has been conservatively estimated that as much as a third of everything offered for sale falls in the realm of "optional consumption." That is, consumers can "take it or leave it" without any immediate personal inconvenience. But if they decide to "leave it," a terrific economic depression will not be far behind. In such circumstances, advertising—in which, in all of its forms, we are now investing over $10 billion annually—clearly is of crucial importance to our continued prosperity.

In performing its key role in past years, American advertising never realized its full potential. It successfully promoted sales. But it never was called upon to promote an overall economic stability as a direct outgrowth of increased sales.

By successfully promoting both sales and economic stability, as it did in 1954, advertising surely has added new strength to the American economy. It has also added a great new and constructive dimension to advertising itself.

One of the surest means of expanding your sales volume in today's industrial markets is through dominant advertising in the publications directly serving your major customers and prospects.

McGraw-Hill's business and technical publications can give you quick access to the men who initiate, specify and approve the purchases of industrial products and services. Because all are leaders in their respective fields, you are assured a maximum return on your advertising investment when you *concentrate* in the McGraw-Hill publications serving your most important markets.

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THE LYNNCO AIR CURTAIN BLAST FENCE*

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The Lynnco Blast Fence in position behind heavy jet bombardment aircraft.

New off-the-shelf Blast Fence gives full blast control at half the cost

The Lynnco Air Curtain Blast Fence employs a basic principle of aerodynamics to provide effective blast deflection. In addition, the fence acts as a remarkable silencer. Conversation may be carried on behind the fence only 25 feet from the tailpipe.

CHECK THESE FEATURES:

- *Low* initial cost—*no* maintenance costs.
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- Easy to install—easy to dismantle.
- Lightweight—nests for ease in shipping—occupies minimum "real estate" when installed.

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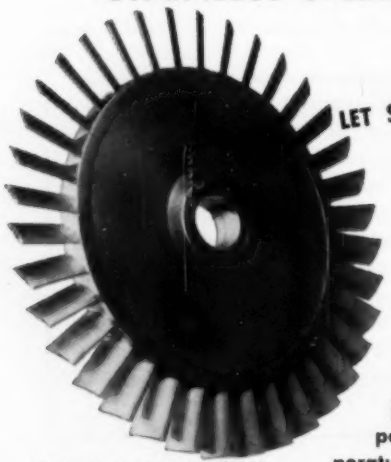
STAINLESS STEEL OR SUPER ALLOY?



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WHO'S WHERE

(Continued from page 23)

Changes

Dr. John Mason, chief-preliminary design, The Garrett Corp.'s AiResearch Manufacturing Division, Los Angeles, Calif.

David C. Pinkerton, manager-advance engineering, Communication Products Department, General Electric Co., Syracuse.

Dr. Montgomery H. Johnson, director of advanced research, and **Dr. Joseph V. Charyk**, director of missile technology, Aeronutronic Systems, Inc., subsidiary of Ford Motor Co., Los Angeles, Calif.

Brig. Gen. Edwin M. Day (USAF, ret.), a member of the president's staff, Fairchild Camera and Instrument Corp., Syosset, N. Y.

Dr. Henry S. Katzenstein, director-research department, Military Engineering Division, Olympic Radio & Television, division of The Siegler Corp., Long Island City, N. Y. Also: **Abe Cohen**, head-military product development, and **Ruby Blumkin**, head-military product design.

A. L. Ervin, assistant to the director of customer relations for planning, Fairchild Engine Division, Fairchild Engine and Airplane Corp., Deer Park, N. Y. Also: **Norman E. Briggs**, manager-airframe customer relations.

Dr. Frank B. Brown, technical director-reliability and evaluation, Crosley Division, Avco Manufacturing Corp., Cincinnati.

Sydney H. Carter, director of sales advertising and promotional material, Temco Aircraft Corp., Dallas, Tex. **Brig. Gen. Luther Stevens Smith** (USAF, ret.) succeeds Mr. Carter as director of public relations.

John E. Dalgleish, manager, Turbo-Rocket Division, Veet Industries, East Detroit, Mich.

Lawrence L. Jacobs, plant manager, Elbeeco Division, Aeroquip Corp., Jackson, Mich.

Peter Bukoff, quality manager-airframe products, Bendix Division, Bendix Aviation Corp., South Bend, Ind.

Dale E. Oyster, assistant to the chief of the Engineering Division, The Rand Corp., Santa Monica, Calif.

T. Ross Welch, general manager, TC components Division of Brubaker Electronics Co., subsidiary of Telecomputing Corp., Los Angeles, Calif.

Vincent Kaye, director of research and development, Control Engineering Co., Detroit, Mich.

John S. Glen, superintendent of communications-electronics, Bonanza Air Lines.

Marcy W. Osborne, Jr., manager-propellant materials, B. F. Goodrich Chemical Co., Cleveland, Ohio.

Maj. Gen. Dudley D. Hale (USAF, ret.), manager-Washington, D. C., office, The Martin Co., Baltimore, Md.

Tom McCracken, coordinator for T-38 production, Northrop Division, Northrop Aircraft, Inc., Hawthorne, Calif.

William E. Cobey, director-helicopter engineering, Republic Aviation Corp., Farmingdale, N. Y.

B. J. Anthony, in charge of the newly established Dayton, Ohio, office, Chance Vought Aircraft, Inc., Dallas, Tex.

Pilot Safety Stressed in Workmaster

London—Production go-ahead has been ordered by Auster Aircraft, Ltd., of a new agricultural aircraft known as the Workmaster. It was designed to the specification of Crop Culture, a British aerial spraying and top-dressing company.

Crop Culture has ordered nine Workmasters and a further order for five has been placed by the French aerial spraying company, Ardic.

First of the 14 aircraft on order made its initial flight Feb. 22, and now is completing flight trials. Major change in the aircraft is installation of a 180-hp. Lycoming engine in place of the previous 135-hp. British Cirrus engine. The manufacturer says the American engine not only enables the heavy load to be carried with ease but leaves power to spare for increased safety margins.

The Workmaster can carry up to 120 U.S. gal. of chemical and will spray at speeds of up to 90-mph. The chemical tank is located beside the pilot, with room also for a second seat for a passenger behind the pilot.

WORKMASTER has 100-gal. capacity agricultural chemical tank beside pilot and there is space for a second seat behind him. Fully loaded takeoff is estimated at 180 yd.

Safety Features

Crop Culture and Auster put a strong emphasis on pilot safety in design of the aircraft. These are some of the features:

- **Chemical tank** is positioned beside the pilot, rather than behind, minimizing the risk of injury in an accident.
- **Specially shaped** tank provides good visibility when flying close to the ground.
- **Jettison valve** is fitted to the bottom of the tank which will enable the load to be dumped in five seconds. The designer says this can quickly increase the rate of climb from 650 fpm. fully-loaded to 1,000 fpm.
- **Pilot's seat** has been strengthened and equipped with a 25G shoulder harness made from chemical-resistant material.
- **Thicker,** bird-resistant windshield.
- **Oversize, low-pressure** tires for taxiing over rough and muddy ground.
- **Hydraulically-operated** disk brakes.
- **Undercarriage** shifted further forward to allow sharper braking.
- **Addition** of pneumatic tailwheel and more robust tail spring assembly.

Tail surfaces of the Auster have been redesigned to improve stability at maximum weights where the center of gravity tends to be aft. Installation of trainer-type ailerons, more sensitive than the older type, makes the aircraft more maneuverable and easier to handle, according to the manufacturer. Controls also are said to be better harmonized.

For increased pilot efficiency, a more comfortable seat has been installed and an effort made to reduce the noise level.

There are engine air filters for both cold and hot air conditions and an emergency air intake which opens if the other is clogged. Anti-locust guards are provided for the intakes and cabin ventilators.

Capacity of the Workmaster places it between the lighter Alpha and heavier, more expensive Agricola in the

Czechs Test Light Twin

Flight test program is underway on new Morava L-200 five-place light twin which is reported to have top speed of approximately 185 mph., cruise speed of 170 mph. and range of 1,000 mi. It has retractable tricycle landing gear, carries fuel in wingtip tanks. Designed for business use and air taxi service, L-200 was shown to public during recent engineering exhibition in Brno, Czechoslovakia.

TINY TOWN OR MIGHTY METROPOLIS *Esso is there . . . at 600 airports from Maine to Texas!* Leave it to those Esso Aviation Dealers . . . to give your plane the knowing kind of service it needs to keep you right on schedule. With an Esso Aviation Credit Card (they're easy to apply for), you can charge almost anything—including gasoline, oil and lubrication (you can't beat those Esso Aviation products) and even tire and battery service, landing fees, overnight in-transit storage and minor emergency repairs. How's that for a good deal?

FREE TO PILOTS! For your free Esso Flight Calculator, handy guide in figuring True Course, Drift Angle and Ground Speed, be sure to see your nearest Esso Aviation Dealer.

ESSO

Auster stable of agricultural aircraft. Cost will vary between $11,200 and $14,000 depending upon the equipment ordered. Auster says deliveries now can be made in 12-14 weeks.

Short Takeoff

Proving flights have shown that the aircraft can take off fully loaded after a 180-yard run, the manufacturer says. This is followed by a steep climb out. Turn-around time during spraying operations is estimated at three minutes.

The Workmaster has a wingspan of 36 ft., length 23 ft. 7 in. Its weight is 2,550 lb. and it can carry a payload of 950 lb. in addition to the pilot. Maximum level speed is 104 mph. with an economic cruising speed at 65% power of 88 mph. Fuel consumption at economic cruise is 7½ gph.

Fuel tanks, totaling 38.4 U.S. gal., have been shifted from the fuselage to the wings in the new model. A constant-speed propeller is standard equipment.

Controls have been positioned so that throttle and prop pitch both can be handled with one hand.

Auster says the Lycoming's power/weight ratio was better than that of any other engine available.

Fortunately, when Crop Culture came along, the right engine came along at the right time, a company spokesman says. "For some time in this country, we have been sadly lacking in engines of the right power/weight ratio and cost. We also were fortunate in getting quick delivery from the United States."

The 180-hp. engine with its constant-speed propeller has been installed at the same weight as the previous 135-hp. engine with fixed pitch.

Rotary Atomizer

The Micronair rotary atomizer, designed and developed in England by Britten-Norman, Ltd., an associate company of Crop Culture, will be standard equipment on the Workmaster. Each aircraft is fitted with two of these atomizers, one on each wing tip. Spray chemical is fed from the chemical tank in the fuselage to the atomizers.

The firm says that in insecticidal work it is possible to cover an acre with only ¼-gal. of spray using the atomizers and that it seldom is necessary to go above 2 gal. an acre in any other type of work.

Auster says there is as yet no top-dressing version of the Workmaster but that such an aircraft will follow. It also is considering the possibility of modifying the Workmaster for passenger and load-carrying. The top hatch, designed for removal of the chemical tank for cleaning or overhaul, would admit packages up to 33 in. by 28½ in.

Crop Culture placed its order for the Workmasters at the end of last December, and the first aircraft flew only 53 days later. The aerial spraying and top-dressing company began operations in 1955 using converted de Havilland Tiger Moth biplanes. It now has a fleet of over 30 aircraft in use or on order. It operates not only in the United Kingdom but also in the Sudan, North Africa, Mauritania, British and French West Africa.

In the six months ending December, 1957, the company sprayed over a quarter of a million acres in the Cameroons. It maintains a permanent base in the center of this African banana-growing area.

USSR Light Twin Attains 143 Mph.

Antonov-designed An-14 Pchelka (Little Bee) high-wing short-haul aircraft has top speed of 143 mph. and range of 330 mi. carrying six passengers and 330 lb. of baggage or cargo, official Russian sources revealed.

Two Pchelkas are undergoing flight test and an agricultural version is being built. Especially designed to operate from unprepared fields, plane is powered by two Ivchenko AI-14R radial engines. Instrument panel is stated to include radio direction finder, radio altimeter and other weather equipment.

HE'S FLYING THE NOSE SECTION

An adverse accumulation of tolerances can ruin an engine. Every part can be within the manufacturer's wear limits. Yet, when the engine has been assembled, the oil flows are not acceptable.

The condition is always caught at Final Test. But that is the expensive place to find it. The trouble could be in the nose, the rear, or the power section.

This Airwork designed rig checks each section before Final Assembly, using oil at pressures and temperatures equal to operating conditions.

By flowing each section to Airwork's own limits, we know performance will be satisfactory on Final Test. And, since every passage has been packed with oil in the shop, we know the engine gets immediate lubrication at all vital points.

Send your next engine to Airwork . . . where careful craftsmanship produces better engines.

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CAPABILITIES . . . Manpower, Tools and Experience

Rugged and Right...Will Travel Anywhere

BIG aircraft performance with small aircraft landing field capabilities – these factors make the Beechcraft L-23D the finest in Army Aviation! This new Beechcraft is **safe** too. With the propellers, engines, and low-wing structure "running interference" for the occupants in case of a forced landing, there is only **4½ per cent** of the weight of the airplane above and behind them!

Thirty-four inches of ground clearance make the L-23D one of the best operating planes in and out of small fields. Also, there's the **availability** factor. The L-23D has the lowest "down time" of any airplane in its field. In other words, it's **designed** and **built** to be useful!

The L-23D is just one of four different types of airplanes now being produced at Beechcraft. Other projects include advanced research and development into the fields of missiles and target aircraft; engineering test programs on aircraft emergency escape systems; and classified projects in the advanced fields of aerodynamics, cryogenics, thermodynamics, and aircraft range extension.

To put Beechcraft's capabilities to work to solve your research, development, or production problems, telephone or write the Contract Administration Division today.

Beechcraft

BEECH AIRCRAFT CORPORATION • WICHITA, KANSAS, U. S. A.

Beech Builds: U S Navy T-34 • USAF T-34 • U S Army L-23 • Bonanza • Travel Air • Twin-Bonanza • Super 18 Executive Transport

PRIVATE LINES

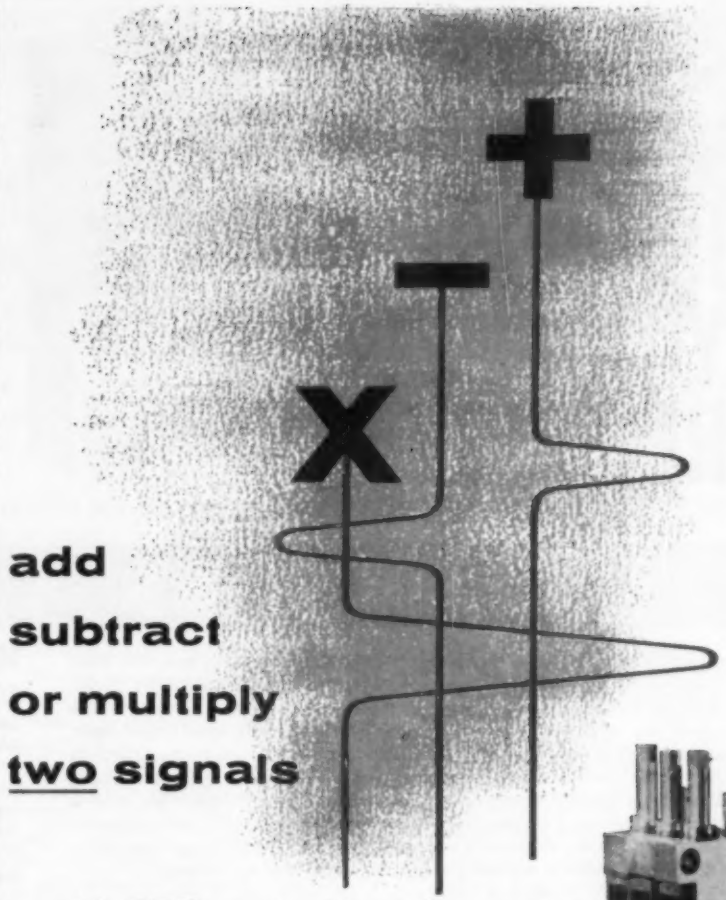
Flight Safety, Inc., LaGuardia Marine Terminal, installed Sperry integrated instrument system in its flight translator used by corporate pilots for checking instrument flying proficiency. Unit already has a Collins integrated flight system and standard instrumentation.

Annual Miami-Havana Air Cruise May 10-14, for private pilots is designed around an all-expense package tour costing some $40 plus hotel rooms, which are offered at special low rates. Program encompasses sightseeing trips in interior and city. Takeoff is from Tamiami Airport, Fla., planes will land at new Baracoa Airport, Havana, which will be dedicated during the tour. For details, write: James G. Pace, cruise director, 310 S.E. 2d Ave., Miami.

USAF's first class of primary students to fly jet trainers graduated at Bainbridge Air Base, Ga., March 14. Class, planned to prove the Cessna T-37A's proficiency in the training mission, had only 30 hr. previous flying time in piston-engine Beech T-34As before they went into T-37As. Each student received 150 hr. total flying time in this experimental phase; course proved that job can be done with 100 hr. flying time. Student academic and flying grades were also higher than normal indicating higher motivation than ap-

Export Via Air

Piper PA-18-A Super Cub agricultural airplane, one of a trio destined for Wales and Germany, is off-loaded from a Seaboard & Western Airlines' Super Constellation at Shannon Airport. Planes were assembled and flown away two days later. Seaboard & Western reports it has been averaging airlift of some five planes monthly to Europe in past year in addition to a total of a half-dozen helicopters.



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two signals

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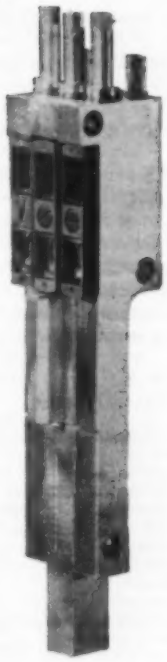

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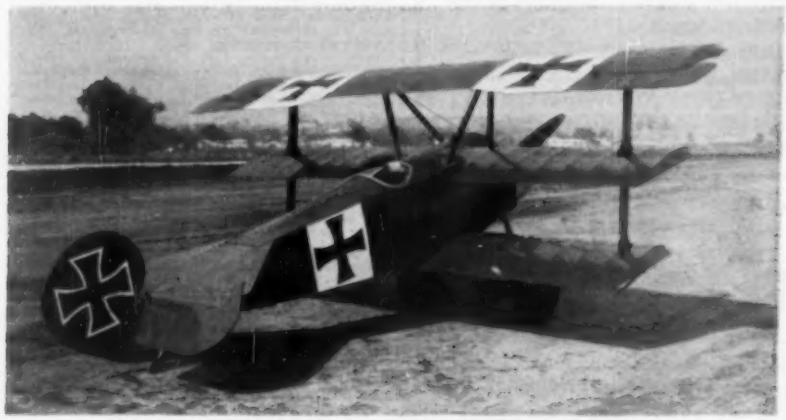
D18 Performance Improved

Modernization of Beech D18, including changing angle of incidence of horizontal stabilizer and adding E18S-type wingtip extensions, has improved executive plane's performance—particularly stall and single-engine flying characteristics. Single-engine safe speed has been lowered to approximately 94 mph. from 104 mph., according to Aviation Service Division, Spartan Aircraft Co., which modified the airplane for C. L. McMahon, Inc., independent oil firm. Other modifications include installation of skylight windows in cockpit roof, addition of picture windows, increase in cabin area and improved access to cockpit.

peared in previous all-piston course. First class graduated from Southern Airways' civilian contract school, which phased out completely on T-28A in 1959, previous second trainer in primary course. Base will gradually increase its T-37A complement to about 100 aircraft.

Consolidated sales for Pacific Airmotive Corp. and subsidiaries for fiscal year ended Nov. 30 reached an all-time high for the firm of $31,709,546 with net income after taxes being $564,204. Commercial sales also achieved a new high, representing more than 70% of the company's total. PacAero has experienced drastic reduction in military airframe overhaul work at its Chino Division and doubts that operation can be handled economically this year unless there is a change in Defense Department policy.

Pillsbury Mills, Inc., acquired a Remmert-Werner converted DC-3 with 14 passenger seats. Equipment includes: Bendix X-band radar, Sperry A-12 autopilot with extra Gyrosyn compass and H6 electrical gyro horizon; Collins 51X2-17L7 880-channel VHF communications and landing gear doors.



Historic Fighter Flies Again

This realistic replica of a World War I German Fokker Dr. I triplane fighter was flown for the first time early this month on the West Coast. Built at a cost of approximately $1,000 by Harry Provolt, Sunland, Calif., from authentic data and drawings, the red-painted triplane uses a 125-hp. Warner radial engine in place of the 110-120-hp. Obersel rotary fitted to standard original configuration. Plane has a small tailwheel replacing normal skid to simplify taxiing. Provolt previously built a replica of a Bleriot XI used in movie "Lafayette Escadrille" (AW Aug. 19, 1957, p. 135) and is currently building a WW I French Nieuport 17 fighter as part of his movie fleet. Restoration and building of historic and antique aircraft has taken a sharp upturn in recent years.

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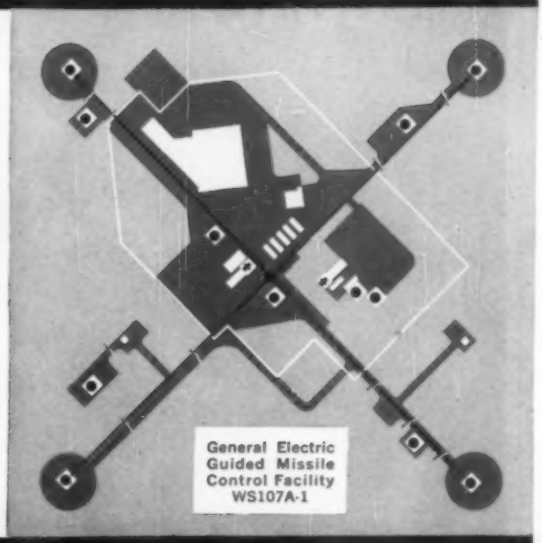

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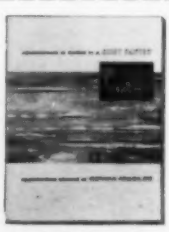

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P-6778, Aviation Week
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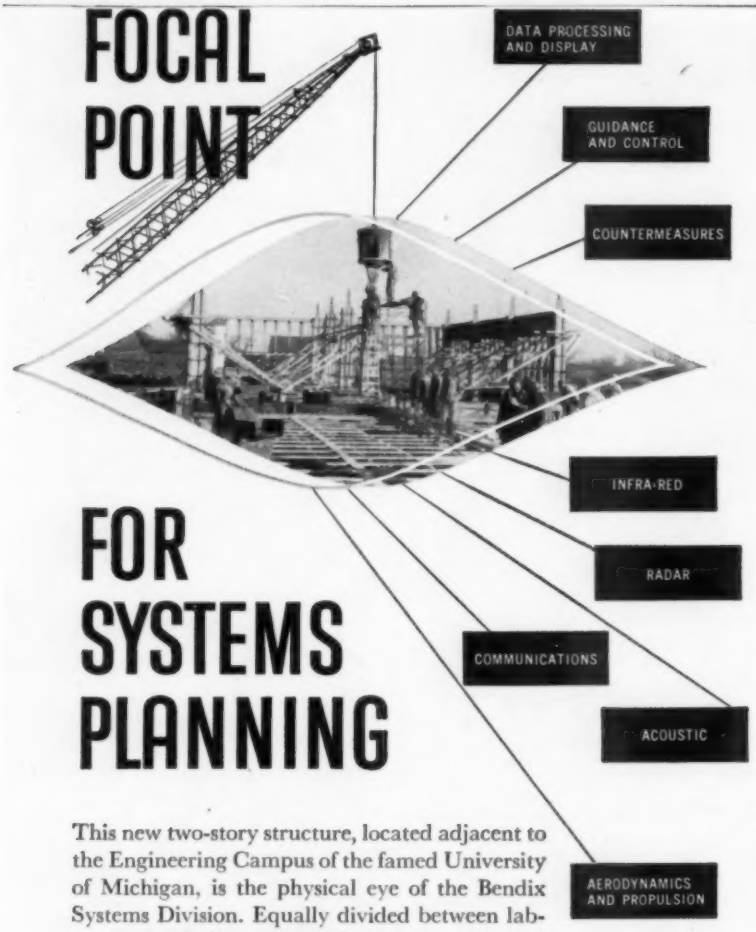

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LETTERS

On Al Boyd

Re your "Salute to Al Boyd" (AW March 17, p. 13), congratulations.

Dick Johnson
Chief Engineering Test Pilot
Convair
Edwards, Calif.

Boyd Gives Credit

I would like to express my most sincere appreciation for the great tribute paid me, the United States Air Force, and the men who contributed so much to the future of aviation through their efforts in experimental flight test during the period 1945 through 1957.

I only wish that I were deserving of this wonderful praise.

The credit, however, must go to all members of the engineering and test team and especially the following:

Gen. Benjamin W. Chidlaw, my boss during the major portion of this period, who not only had confidence in us but inspired us as a great and visionary leader.

Without his support and guidance the success attained could have never been realized.

Dick Horner, present Assistant Secretary of the Air Force (research and development), for his outstanding engineering capability and direction of the engineering effort.

Maj. Gen. George F. "Poo" Smith, who, as director of special projects, had sufficient confidence in our flight test capability to assign us the responsibility for the X-1 program.

Fred Ascani, my able assistant during this period, who, as a member of the test team, provided imagination, management support and direction in the shaping of the organization and the supervision of personnel.

Jack Ridley, as the engineering partner of Chuck Yeager, who furnished the engineering guidance that made possible the success of the X-1 research program.

Si Sibilsky, of the Wright Air Development Center, for his engineering leadership and contribution as one of the outstanding civilian engineers of the period.

Paul Bickle, who contributed as did Sibilsky and who is now the technical director of the Air Force Flight Test Center.

Of the great pilots with whom I was associated during this period, I shall name only a few:

Chuck Yeager, Pete Everest, Dick Johnson, Kit Murray, Russ Schleeh, Tom Collins, Pat Fleming, Guy Townsend, Bob Hoover, Wayne Eggert, Slade Nash, Gus Lundquist, Bob Cardenas, Ken Chilstrom, Bill Council, Joe Wolfe, Hugh Bowe, Glen Edwards and Ivan Kincheloe. These men, with the aid and assistance of the outstanding engineers named above, certainly earned the respect and admiration of the aviation industry.

I am certain that I speak for all of us when I say that we are deeply grateful to you for the recognition expressed in your editorial,

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

which appeared in the March 17 issue of Aviation Week.

Albert Boyd
Vice President
Westinghouse Electric Corp.
Baltimore, Md.

Color Prints

As USAF representatives here at the U. S. Army Air Defense School, we have a continuing and vital need for up-to-date, high quality graphic aids on Air Force equipment. In the March 3 issue of Aviation Week (Vol. 68, No. 9), the color prints, particularly those on the cover and p. 71, 89 and 217, outclass any that we have been able to obtain from official military sources.

I would greatly appreciate receiving the above color prints from which color 35mm slides can be reproduced, and which can be framed for wall display. The use will be restricted to military. I will remit all costs.

Incidentally, the March 3 issue of Aviation Week is the most complete and comprehensive coverage of modern aviation I have ever seen in a single publication. As always, your magazine is a boon to airpower.

C. C. McFarland
Colonel, USAF
Senior Air Force Representative
U. S. Army Air Defense School
Fort Bliss, Tex.

Inured to Isolation

The story "Work Helps Man Endure Space Isolation" (AW March 17, p. 37) states on p. 43, "A medical officer who volunteered for the test . . . could not remain in the (isolation) chamber for two full days."

Why don't they try putting a housewife, whose children are of school age, into the chamber? She's used to isolation.

Edna E. North
Danbury, Conn.

Cognizance Taken

Please excuse my delay in thanking you for the story contained in the Jan. 6 issue of Aviation Week (p. 76) which resulted from your survey on the Wescon technical papers. It was certainly a good coverage and contained much information which we have taken cognizance of in planning for the 1958 Wescon program.

In looking at the results of the survey, we were impressed by the fact that 50% of the replies indicated a rating of excellent or good for the technical papers. When one considers that the audience for such a program is generally quite critical, we feel that this result was really quite complimentary.

Wescon has been striving over a long period of time to improve the quality of the papers delivered at the technical sessions. The verbal comments which we received after the last Wescon, by those who had attended several previous Wescons, indicated that the quality was quite improved over previous years. For that reason, the headline of the article which read "Quality of Papers Sinks, Engineers Say" rather shocked us.

I was interested in your comments regarding pre-prints. In previous years we have supplied them for most of the papers delivered during Wescon. We eliminated that policy in 1957 when the National IRE office agreed to publish a complete IRE-Wescon Convention Record. We are, for 1958, reappraising the idea of supplying preprints based on the comments in your article.

We certainly hope that in 1958 we can prove that the results of your survey have been carefully considered and given full consideration.

Don Larson
Business Manager
Western Electronic Show and Convention
Los, Angeles, Calif.

Magnificent Job

A few pertinent items should be brought to the attention of readers who may have been misled by the "El Paso Taxpayer" (AW Dec. 23, p. 102). He obviously is unaware of the real contributions of civil servants to the country's technical efforts.

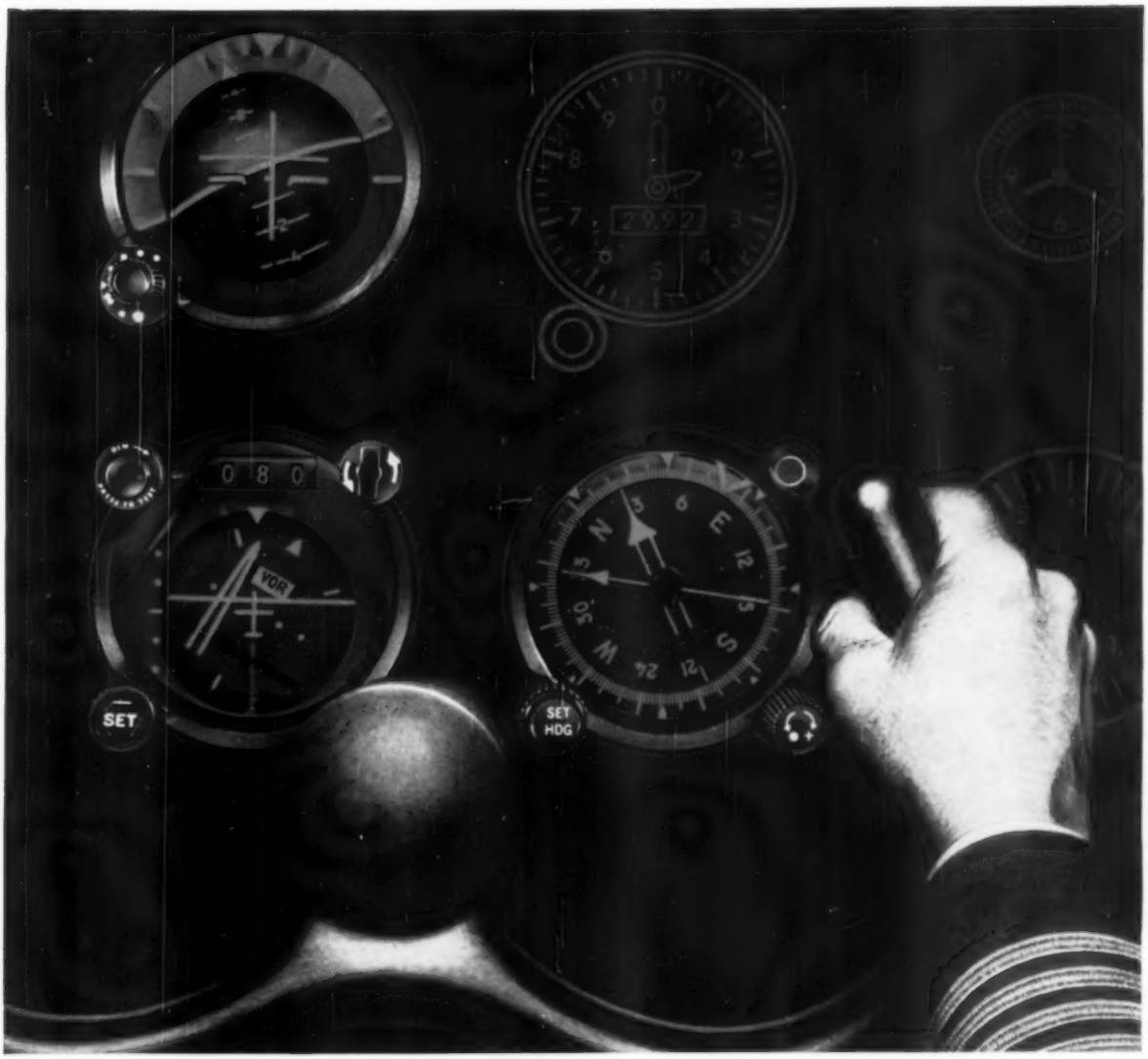
NOTS China Lake is staffed predominantly by civil service personnel. NOTS developed the Sidewinder missile which is one of the most lethal air-to-air missiles in this country's arsenal. NOTS has made outstanding progress in design and development of rockets and fire control systems.

NACA civil servants developed the area-rule concept for increasing performance of high speed aircraft. A very large percentage of the U. S. original aerodynamics research is conducted at and by NACA. Some of the best scientific talent in industry was drawn from NACA. Jupiter is a product of civil servants at ABMA Huntsville.

The Naval Air Missile Test Center at Point Mugu has over 2,000 civil service personnel. These people have been highly responsible for evaluation of the missiles in our Navy today, including the only operational submarine-launched missile.

Many letters have appeared in your magazine in which engineers of industry have delineated the incompetence of their activity. Let us recognize that there are good and not so good aspects of both industry and government employe philosophies. None is perfect. Many civil servants are doing a magnificent job in research and development at the government laboratories and test facilities, and merit credit rather than discredit. I can only assume the "El Paso Taxpayer" is unaware of these facts.

A Civil Servant
U. S. Naval Air Missile Test Center
Point Mugu, Calif.



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The Sperry Integrated Instrument System is an important contribution to aircraft instrumentation. It provides a Zero Reader* Flight Director which has been effectively combined with the Gyro-Horizon, pictorial presentation of radio beam position, and numerous other desirable features aimed at operational simplification, greater flight safety, space saving and reduction of maintenance.

Reading white in daytime, the instruments glow a rich "aviation red" at night. This color aids night vision, reducing the adjustment a pilot's eyes make as his gaze shifts between instruments and outside objects. Color remains stable because permanent filters are used instead of stained lamps. And illumination is uniform at all brightness settings. Shock-resistant lamps—as many as 10 to a single instrument—operate below their rated voltage to assure long service life and reliable illumination.

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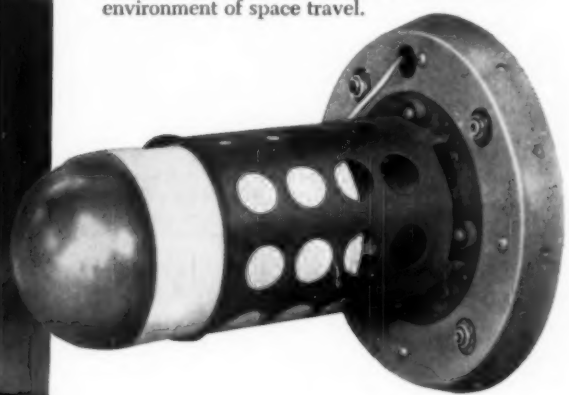
Elastic Stop nuts... *make first trip to the exosphere*

An artist's version of the launching of the Far Side rocket. The four-stage vehicle was carried to an altitude of 100,000 feet by a polyethylene balloon made by General Mills. Fired straight up through the balloon, Far Side rocketed to the greatest distance from the earth ever reached by a man-made device. The prime contractor for the Far Side project was Aeronutronic Systems, Inc., a subsidiary of the Ford Motor Company, for the Air Force Office of Scientific Research (ARDC).

What were the requirements for an exploratory trip into the exosphere? The success of project Far Side established these two among others:

1. **A launching platform located as far as possible above the effects of atmospheric drag**
2. **The use of hardware of proved ability**

Some of this hardware can be seen in the close-up of Far Side's nose-mounted payload. In the photo showing the payload before the nose cone was placed over it, three of the four Elastic Stop nuts used to secure the third stage rockets to a retaining ring are clearly visible. They are standard ESNA hex nuts—with the familiar red nylon insert. These are the self-locking fasteners that have proved their ability to hold tight under the severest requirements of aircraft operation, through almost three decades of progress in aircraft design and construction. And now they have proved their ability to meet the requirements and unusual environment of space travel.



The complete line offered by ESNA includes self-locking nut designs for every missile, aircraft and power plant application. They cover a range of operating temperature requirements from −80°F. to over 1300°F. For specific information, send the details of your application to ESNA.

Write to Dept. S17-425, The Elastic Stop Nut Corp. of America, 2330 Vauxhall Road, Union, New Jersey

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